S. HRG. 103-509

NASA'S FISCAL YEAR 1995 BUDGET

Y 4.C 73/7:S.HRG.103-509

NASA's Fiscal Year 1995, Budget, S....

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED THIRD CONGRESS

SECOND SESSION

MARCH 2, 1994

Printed for the use of the Committee on Commerce, Science, and Transportation

JUL 19 1994

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NASA'S FISCAL YEAR 1995 BUDGET

WEDNESDAY, MARCH 2, 1994

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY
AND SPACE OF THE COMMITTEE ON
COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The subcommittee met, pursuant to notice, at 2:38 p.m. in room SR–253, Russell Senate Office Building, Hon. John D. Rockefeller IV (chairman of the subcommittee) presiding.

Staff members assigned to this hearing: Elizabeth Inadomi, staff counsel; and Louis C. Whitsett, minority professional staff member.

OPENING STATEMENT OF SENATOR ROCKEFELLER

Senator ROCKEFELLER. Good afternoon. I welcome everyone to this subcommittee's review of the President's proposed budget for NASA in fiscal year 1995.

I want to emphasize that the testimony received and the issues raised at this hearing today will help frame our discussions for the whole 1995 NASA authorization bill, which is going to be done and passed this year.

The last time that this subcommittee met to look into NASA's work was November 1993. As all of you recall the space program at that time was beset by a number of difficulties.

And I raise the subject only because subsequent to that hearing, there have been spectacular successes, including a triumphant repair mission which I think did a lot not only for NASA, not only for looking into distant places, but for our people in this country and confidence in NASA.

The first space shuttle flight with a cosmonaut on board just this past month is also a new focus, a new strength, is a new arrangement for NASA.

I commend all of you. You, in particular Dan, and all of the rest of you at NASA for pulling together and making these missions as successful as they have been.

But, of course, the fiscal 1995 budget request may prove to be a difficult problem for NASA. NASA's request of $14.3 billion is $250 million less than the 1994 appropriation of about $14.6 billion. There are only seven Agencies in the Federal Government that got an increase and NASA was not one of them.

This proposed budget reduction means belt-tightening for NASA's programs, personnel facilities, and contractors, and Dan Goldin, you sir have had some very specific things to say about

that—warnings, concerns, and specific statements, and you will have no doubt more today.

NASA says it can absorb these reductions without canceling any of its major programs. I am concerned from my own point of view that the total price tag for each program will increase because there will be schedule delays. That is happening already. And methods commonly used to shoehorn projects into tight annual budgets, those are classic methods but they tend not to make things less expensive but more expensive and problems not less but greater.

Today, therefore, we have to examine with very distinct honesty the impact of these reductions on NASA and thoroughly discuss the budget issues and implications, and we will be open and honest with each other.

In many ways, I consider this hearing to be a continuation of what we did on November 16, 1993, when we focused on NASA's efforts to restructure itself and on NASA's priorities for fiscal year 1995.

As you may recall, Dan Goldin, the Administrator, testified that the space shuttle, the Space Station, Mission to Plant Earth, aeronautics, and space science in that order were NASA's priorities.

At that hearing, Norm Augustine reiterated that space science was the first priority as he saw it. With the exception of the administration's proposed 18½ percent decrease for the NASA aeronautics program, the 1995 fiscal budget request appears to reflect those priorities.

NASA's $14.3 billion budget request—and I am concerned about this, it is a reduction from previous years—may have very little relevance to the economy and our Nation's changing priorities. That also must be discussed.

As a nation, we can no longer afford to carry out the priorities of the cold war. That is a conversation that all of us are having with everybody these days in Government.

To lay the foundation for greater collaboration between NASA and industry, just yesterday Senator Burns and I just introduced the NASA Technology Investment Act of 1994.

This bill establishes competitiveness and economic growth as new goals for NASA's Aeronautics and Space Program. And we talked with some press on that and I indicated that that is a consistent theme of this administration. Whether it is trade policy, foreign policy, space policy, economic policy, budget deficit reduction policy, everything tends to come back to what affects this country economically in some measure.

We want to help NASA change its way of doing business fundamentally and work more closely with industry to identify technologies that will reap rewards like jobs and growth in the marketplace. That is pedestrian job growth talk, but it rings loud and true to the American people these days.

NASA's budget request for fiscal 1995—Mr. Chairman, do you want me to move?

The CHAIRMAN. Mr. Chairman, you are doing an outstanding job.

Senator ROCKEFELLER. The NASA fiscal budget request for 1995 asks for less money than what it used to seek in previous years,

and yet its budget claims that it does not have to cancel programs to live within those constraints. That I think we need to discuss.

Moreover, we know that these times are getting not just tight in this year but also in future years, and will squeeze NASA's budget even more.

This request suggests aeronautics and space science as the two areas to reduce our investment. Norm Augustine would not agree with that. I am not sure I will. Both of those are key program areas which arguably have contributed the most to the U.S. taxpayer.

This sums up the situation as I see it. We do not have the capacity to grow money for NASA. Perhaps we can do that at zero gravity but you have not reported that yet to me.

We do have the ability and the responsibility to ensure that we set the funding levels and priorities for NASA so that it can truly pursue objectives that we all want in our aeronautics and space program.

And I look forward to hearing you, our one and only witness, Dan, accompanied by two very distinguished people, who will shed enormous light on all of these issues.

[The prepared statement of Senator Rockefeller follows:]

PREPARED STATEMENT OF SENATOR ROCKEFELLER

Welcome to the Subcommittee's review of the President's proposed budget for the National Aeronautics and Space Administration in fiscal year 1995. I want to emphasize that the testimony received and issues raised at this hearing today will help frame our discussions for the FY 1995 NASA Authorization bill.

The last time this Subcommittee met to look into NASA's work was on November 16, 1993. As all of you recall, the space program was beset by a number of spacecraft losses and failures. I raise this subject only to point out that, subsequent to our hearing, it seems—from the outside—that NASA has turned a corner. The triumphant repair mission of the Hubble Space Telescope, late last year, and the first space shuttle flight with a cosmonaut onboard, just this past month, signal renewed focus and strength in NASA. I commend all of you at NASA for pulling together and making these missions successful.

The value of our Nation's activities in human space flight has been demonstrated very clearly in these past two missions. Without human intervention, the space science community would be denied the potential for discoveries about our universe that is offered by the Hubble Space Telescope. Who would have imagined back in 1958 when NASA was created, that the race for space would lead to a Russian Space Agency cosmonaut flying onboard the space shuttle as part of an integrated crew? It is through these types of missions that I believe that NASA will excite the American people once again and demonstrate its commitment to tackle difficult problems.

The FY 1995 budget request may prove to be one of those difficult problems for NASA. NASA's request of $14.3 billion is $250 million less than the FY 1994 appropriation of about $14.6 billion. This proposed budget reduction means belt-tightening for NASA's programs, personnel, facilities, and contractors. However, NASA says it can absorb these reductions without canceling any of its major programs. I am concerned that the total price-tag for each program will increase due to schedule delays and other methods commonly used to shoe-horn projects into tight annual budgets. It is important that in our hearing today, we examine with real honesty the impact of these reductions on NASA and thoroughly discuss these budget issues.

In many ways, I consider this hearing to be a continuation of our hearing held on November 16, 1993, where we focused on NASA's efforts to restructure itself and on NASA's priorities for FY 1995. As you may recall, Administrator Goldin testified that the space shuttle, space station, mission to planet earth, aeronautics, and space science were NASA's priorities in that order. At that hearing, Mr. Norman Augustine reiterated the recommendation of the Committee on the Future of the U.S. Space Program; that space science was the first priority. With the exception of the Administration's proposed 18.5 percent decrease for the NASA aeronautics program, the FY 1995 budget request appears to reflect those priorities. In fact, with the rel-

atively flat budget projected for NASA through FY 1999, it becomes apparent that the aeronautics and space sciences programs both stand to lose.

Like my colleagues in the Senate and in the House of Representatives, I am concerned about the balance of aeronautics and space programs, of "piloted" and "unpiloted" missions. Further, I am concerned that NASA's $14.3 billion budget request, while a reduction from previous years, may have little relevance to the economy and our Nation's changing priorities. As a Nation, we can no longer afford to carry out the priorities of the Cold War. To lay the foundation for greater collaboration between NASA and industry, just yesterday Senator Burns and introduced the NASA Technology Investment Act of 1994. This bill establishes competitiveness and economic growth as new goals for NASA's aeronautics and space programs. We want to see the dual-use approach extended to NASA's missions. We want to help NASA change its way of doing business fundamentally and work more closely with industry to identify technologies that will reap rewards like jobs and growth in marketplace.

NASA's budget request for FY 1995 asks for less money than what it used to seek in previous years. And yet, its budget claims that it does not have to cancel programs to live within these constraints. Moreover, we know that times are getting tighter in future years, and will squeeze NASA's budget even more. This request suggests aeronautics and space science as the two areas to reduce our investment—key program areas which arguably have contributed the most to the U.S. taxpayer. This sums up the situation as I see it. We don't have the capacity to grow money for NASA. We do have the ability and responsibility to ensure that we set the funding levels and priorities for NASA so it can truly pursue the missions and objectives that we all want in our aeronautics and space program. I look forward to hearing our witness, Administrator Dan Goldin, who will shed much light on these issues.

Senator ROCKEFELLER. I yield clearly and obviously to the distinguished full committee chairman, Senator Hollings.

OPENING STATEMENT OF SENATOR HOLLINGS

The CHAIRMAN. Thank you, Mr. Chairman. As you hear these witnesses, we are into the short rows on money. We favor all the programs. How do you keep up the quality of the programs, particularly our astronaut program and everything else, and then move forward into all the other new fields, the other desired fields?

And I have been trying to hold tight on to the formative program and very cautious before we venture into even more, particularly in light of the cuts.

So, I thank you for your leadership and ask consent that you include my opening statement in the record.

Senator ROCKEFELLER. The consent is, I think it is safe to say, given.

[The prepared statement of Senator Hollings follows:]

PREPARED STATEMENT OF SENATOR HOLLINGS

With this hearing, the committee begins its annual review of the NASA budget request. I am encouraged that the fiscal year 1995 budget request for NASA finally reflects the budget reality in which we all must live.

In FY 1995, NASA is requesting $14.3 billion, $250 million less than its FY 1994 appropriation. This is the first time in over 20 years that the President has requested a decrease in NASA funding. In addition, the multiyear run-out estimates a flat budget over the years rather than the traditional trend upward. From a broad perspective, the NASA request appears to demonstrate a reduced but stable funding scenario for the out-years.

However, it appears that NASA plans to carry out virtually all the same projects as before. How is it that NASA can continue to sustain the Space Station, space shuttle, aeronautics, space science, and Mission to Planet Earth programs when it was struggling to fund these projects before? It appears that NASA plans to "do more with less," deriving reductions through efficiencies compelled throughout the agency. In this way, the budget request intends that required budget reductions can be met while preserving current projects from cancellation.

I am concerned, however, that NASA is proposing efficiencies without understanding the impact of these reductions on programs, personnel, and NASA field installations. When funding is reduced, something is lost, whether it be in program capability or flexibility.

My greatest concern with regard to funding cuts is the space shuttle program. The FY 1995 budget reduces the space shuttle program over 6 percent. While a 6 percent reduction in the program in and of itself does not represent a large number, total reductions taken in the space shuttle since 1992 will be at 24 percent. NASA has claimed that, with all the reductions, the space shuttle program will ensure safe transport to space for our astronauts. How can continued reductions in the space shuttle program increase only the efficiencies and not increase the risk of another accident?

An examination of the impact of the reductions in the NASA FY 1995 budget request and in the out-years on programs like the space shuttle is of critical importance, keeping in mind that NASA's budget flexibility will continue to be constrained by maintaining the Space Station program. As I have stated before, the Space Station is too expensive for NASA and the Nation at this time. In the Senate, I continue to fight to create jobs and stimulate the economy through small industry technology initiatives such as the Advanced Technology Program at the National Institute of Standards and Technology. Yet, NASA continues to spend over $2.1 billion each year on the Space Station which holds little promise for industry collaboration and U.S. competitiveness.

This is an important hearing. NASA Administrator Dan Goldin must ensure that the reductions in the FY 1995 NASA budget will increase efficiencies and not increase the likelihood of failure in NASA programs.

Senator ROCKEFELLER. Dan, before you begin your statement do you want to introduce your colleagues?

STATEMENT OF HON. DANIEL S. GOLDIN, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION; ACCOMPANIED BY DR. FRANCE CORDOVA, CHIEF SCIENTIST, AND MALCOLM PETERSON, DEPUTY CONTROLLER, NASA

Mr. GOLDIN. Yes, I would like to do that. Mr. Chairman, at the witness table with me on my left is Dr. France Cordova, who recently took on the role of Chief Scientist of NASA to try to bring a focus to our scientific priorities. It is a job that we have not had for a number of years, and France comes to us from Penn State University where she was the head of the astrophysics and astronomy department, and I look for great things from France, and you will be hearing from her during this hearing I am sure.

Senator ROCKEFELLER. I know that to be a very strong program at Penn State, along with many others.

Mr. GOLDIN. And on my right is Deputy Controller of NASA, Mal Peterson, should we have any detailed questions relative to budget.

Senator ROCKEFELLER. He appears to be well documented. [Laughter.]

Mr. GOLDIN. Yes, he has files of material. And in the first row in the back are all the associate administrators of NASA. They all came out of interest and to be here should there be a detailed question in their area. We are prepared to answer any and all questions.

Senator ROCKEFELLER. Good, Dan. That is very thoughtful, and complete, and aggressive on your part.

Mr. GOLDIN. Thank you. Mr. Chairman, I have a formal statement which I would like to submit for the record, and to conserve time I would like to make just a few brief opening statements.

First, I am very pleased to be here to present President Clinton's Space and Aeronautics Program, Civil Space and Aeronautics Program for 1995. We think this is a very tough budget, but this is

a budget that recognizes the economic challenges and fiscal realities of the nineties.

The President has asked NASA to step up and be part of the economic solution in two ways. First, he is asking us to do more with less—less in, more out. He said, NASA ought to be restructured to be more efficient with the taxpayers' money so we could have benefits. And second, we have a paradox. The President has asked us to be more relevant to American society in economic security, in national security, and in inspiration.

We at NASA have stepped up. We believe we can do it. And I would be prepared to answer your questions. I would note that in 11 months we have taken the NASA budget down by about 30 percent from a condition of continual growth to a budget which in real buying power is going to decrease each year over the next 5 years.

I would like to remind Senator Rockefeller and Chairman Hollings that I sat in this room almost 2 years ago to the day when this very committee asked me, as I was undergoing my confirmation hearings, did I understand the problem we had with the economy, that the GAO had reported that the NASA budget was out of contact with reality by $20 billion over the 5-year period, and that the budget could not grow.

And I am pleased to say that the NASA people and the contractors, not individually but as a team, have stepped up to the challenge, Mr. Chairman, Senator Hollings, that you asked us to step up to. And this was a process, this was not a declaration. We had a peer review. The associate administrators, the center directors sat in a room in Washington day in and day out over a period of 6 months to figure out how we address this budget, and each person had to defend the budget to their peers.

We tried to make some very hard decisions and we did not make decisions to make people happy. We made decisions that in some cases are painful. We decided to close facilities to eliminate contracts, to reduce, if you will, the standard of living at work for the NASA employees; to reduce the NASA workforce by 3,600 over the planning period, but to do it in a manner which treats people with dignity; to eliminate tasks that were unnecessary and to eliminate overlap in our centers; to make a decision that if we have problems with programs instead of stretching them out we will make hard decisions to cancel them if we do not do what we say we are going to do rather than continue to overrun.

We set up a brand new system called the Program Management Council which establishes before a program is undertaken we must have a clear set of requirements and an understanding. It reviews any program that triggers a yellow light, that is in trouble, instead of years to make a decision.

We believe we are up to the challenge. We want to contribute to America. We believe NASA is relevant to America. And we believe as NASA touched our lives today based on work we did 30 years ago in new tools for the auto industry, in new tools for the aeronautics industry, in intensive care monitoring and health care that we see today, we think we are going to have an even more powerful role to play for our children.

We are ready to step up to a reduced budget and do more for America.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Goldin follows:]

PREPARED STATEMENT OF DANIEL S. GOLDIN

I am pleased to be here today to speak to you about NASA's FY 1995 budget request. As you know, the President has submitted to the Congress a request totaling $14.3 billion. Clearly, this is a budget plan that reflects the economic challenges and fiscal realities America is facing today. Times are tough, and NASA is stepping up to the challenge. We are part of the solution; we are part of the Administration's commitment to a Government that makes sense and is relevant to America.

Compared to our FY 1994 appropriation of $14.55 billion, this budget is $250 million below that level—almost $650 million below it in buying power. But this budget still supports a balanced space and aeronautics program for FY 1995. It works; it makes sense; it supports meaningful science and technology that will make a difference in people's lives.

During my confirmation hearing before this Committee in April 1992, I stated clearly that NASA was out of balance. The FY 1995 budget request demonstrates that we have delivered on our commitment to restoring balance to NASA programs. We have cut human space flight and increased the science budget and technology budgets. The NASA science programs have increased from $3.3 billion—22.4 percent of our budget—in FY 1994, to $3.5 billion—24.3 percent of our budget—in FY 1995. In fact, this is the biggest Space Science budget ever.

The bottom line is that we are a leaner, tougher NASA and are more in touch with what America needs from the civil space and aeronautics program today.

Formulating the FY 1995 budget was a challenge, partly because we had already, in the FY 1994 submittal, reduced NASA's five-year budget plan by 18 percent. Let me put this FY 1995 plan in perspective. When we came before you just a year ago to present the FY 1994 budget, we had just gone through the "red" and "blue" team reviews of our major flight programs and had accepted the challenge of redesigning the Space Station. We had made an 18 percent cut to the long-range plan, which included major reductions in the costs of the Earth Observing System, the Advanced X-Ray Astrophysics Facility and Cassini. We had deferred the Advanced Tracking and Data Relay Satellite System (TDRSS-II) and flattened funding for the Advanced Solid Rocket Motor (ASRM). For FY 1994, we submitted a budget request of $15.3 billion, rising to $15.7 billion for FY 1995 and $16.8 billion in FY 1998.

As you know, Congress appropriated $14.55 billion for FY 1994, and in the process, canceled several programs—the ASRM, the AXAF-S, Shuttle structural spares and the Search for Extraterrestrial Intelligence. In addition, many other programs were reduced, including our support to the National Aerospace Plane (NASP) program and our civil service salary and expense account and personnel. Congress added the Near-Earth Asteroid Rendezvous mission, locality pay for civil servants and provided the funding for cooperative activities with the Russian Space Agency consistent with the Administration's interest. The net effect of these actions reduced the budget estimate of $15.7 billion for FY 1995 down to $15.4 billion.

Now we are looking at a $14.3 billion budget for FY 1995—down more than $1 billion from the level planned last year. But, we are maintaining our key initiatives in aeronautics and space in this budget. We have not canceled any major programs. This budget still provides for: a safe and viable Space Shuttle flight program, the continued utilization of the refurbished Hubble Space Telescope, the Earth Observing System, the Cassini mission to Saturn, the Advanced X-Ray Astrophysics Facility (AXAF-I), and the international Space Station, and two vital programs to our nation's competitiveness in aeronautics—the High Speed Civil Transport and Advanced Subsonic Transport programs.

We are also continuing other smaller programs that are key to our future: the International Solar Terrestrial program, the Space Science Explorers, the Gravity Probe-B mission, now renamed the Relativity Mission, the Earth Probes, environmental observations and astronomy research aircraft, the X-31 aircraft and SR-71, the new Perseus remotely piloted vehicle, Space Shuttle payloads of technology experiments, science and Earth observations, and balloons and sounding rockets.

We are continuing planned cooperative space activities with our traditional international partners. Budgets for space efforts are tight throughout the world, and there is mutual interest among other nations and NASA to cooperate in order to bring down costs. We are conducting discussions with several countries—from members of ESA, to Kazakhstan, to Latin American nations, and others—to combine our capabilities and expand scientific opportunities in space.

Those are the programs we are maintaining. Let me discuss the items we have cut. We asked everyone in NASA to tighten their belts even further. In many pro-

gram areas, we have not allowed for adjustments to keep up with inflation. We have asked the Space Shuttle program to press even harder for savings. We have reduced our personnel even further. We have cut funding for computer acquisitions and services; we are terminating leases for office space; and we have slashed our institutional support contractors wherever possible.

Within our field installations, facilities of marginal value will be closed. At Headquarters, we are continuing to reduce administrative support contractors. Managers at all levels of this Agency can tell you how tough a process this has been. But, the bottom line is that we are committed to preserving a balanced aeronautics and space program, and this is the price we are willing to pay.

I have described some of what we have done to reshape our programs. Before I move on to the challenges still ahead of us in this five-year budget plan, I want to go into further detail about an endeavor that has been a lightning rod for both enthusiastic support and deep concern. I am talking about our new era of cooperation with the Russians and its impact on the international Space Station.

Our cooperation with the Russians in space is based on hard headed realities. We believe Russian capabilities will have a tremendous pay-off for the United States. America has always done bold things, and it is time to reach out and grasp an opportunity that offers dazzling promise. One big and nearly immediate pay-off will come from the Mir missions, which will give us extremely valuable on-orbit experience. It is impossible to understate the importance of this type of experience—it is exactly what made the mission to repair the Hubble Space Telescope a success. After all, you can perform brilliantly during ground simulation, and still flunk in space, unless properly prepared.

Furthermore, working with the Russians will give us knowledge transfer. They have been operating Mir safely since 1986. They have knowledge about safety issues, gleaned from long-term experience in space, that we simply do not have.

In addition, Russian involvement in the Space Station will certainly mean a more robust and safer Station. That is the reason we, along with our other partners—Japan, Canada and Europe—welcomed Russia into the project last December. Russian participation is going to save us money, and it's going to mean that we begin deploying the Station earlier than possible without their participation Russian participation also is going to give us access to more than one launch system. We will have dual communications and dual mission control centers. But the U.S. is responsible for command and control management. The Congress asked us to make that clear, and we have delivered.

At the same time we welcome greater Russian involvement with us and our international partners, we are also proceeding with prudence and are mindful of our obligations to the Congress and the American people. To protect our vital interests, we have safeguards in place at several levels. For example, we have an alternative plan if the Russians withdraw, and we have specific protocols and prohibitions to bar the transfer of sensitive technology or information.

We intend to work with Russia through incremental engagements. We will walk before we run and run before we fly. We are doing that. We are taking those cautious but courageous steps. We already have flown a cosmonaut in a U.S. Shuttle. Next is the STS 71, when we will dock with Mir, and that will be followed by five to nine additional flights to Mir. U.S. astronauts Bonnie Dunbar and Norman Thagard have just left to Russia, to become the first Americans assigned to Russia's cosmonaut training program. We are building a relationship with Russia.

There is something else here at stake besides a more robust Station and space program. If we tell our international partners that America will not stay the course, if we close the door on our partners and the Russians, it may be decades before it opens again. The signal we would send to our partners and others would be unmistakable. The Russian people take extraordinary pride in their human space flight program. We cannot turn away from their offer to engage the programs of these two great space-faring nations. We cannot turn away from this moment in history. Just as cooperation with our traditional international partners has reaped tremendous benefits for the U.S., this new venture with Russia will enhance the returns to all participating nations.

I am proud of our redesigned Space Station and the Administration's decision to expand the-partnership to include Russia. This will be a success story; it will be history-making. I want to recognize the support for the Station that this Committee showed through some difficult times. The Station started out with a price tag close to $3.1 billion a year and we have brought that down to $2.1 billion. Your support has been critical in developing a Station that costs less and will do better science.

Let me turn now to what I believe are some of the challenges ahead for NASA in this budget.

First, we face the challenge of incorporating new science missions into our long-range budget plan. We could not solve every single challenge in the FY 1995 budget process. New starts in the outyear budgets could amount to a $100 to $300 million per year out of a total budget of over $14 billion—this could be well below three percent of NASA's total budget. Given this overall level of resources and our commitment to have a balanced science program through the remainder of this decade and beyond, I am confident that these new science starts can be incorporated into our outyear budgets. We have the time and creativity to do so but we also need your help to ensure that we have a stable budget. We are pushing all our programs to be smaller and cheaper. If NASA's budget to be reduced, it will make it impossible to divert any savings we achieve from this new way of doing businesses into new science starts.

We do have tools we can use to get more for less from out-year budgets. One of our most powerful tools is the Small Satellite Technology program, a 1994 initiative. This program is exactly what we mean when we talk about doing things "better, faster, cheaper" at NASA. The development of new technology through this program, such as advanced payload concepts, along with the fact that we'll be using industry commercial standards instead of government specs, will bring down mission costs dramatically. We are looking at costs on the order of $100 million to $150 million per mission instead of a half a billion dollars. Furthermore, this effort will be led by industry teams—a revolution in the way we do business. Only two to four people in the management office are going to be NASA employees.

We stepped up to the challenges of the 1994 budget approved by Congress and have a healthy, balanced program. We have been given another reduction in the President's 1995 request and are dealing with that with the same solid result. Recently, I met with 50 top executives of the aerospace industry. On March 7, I'll be meeting with top scientists. We also plan to continue meeting with Members of Congress, the public, contractors and other constituent groups. I am confident we will resolve our out-year challenges.

Second, we are facing a challenge to our industrial base of contractors in a period when defense funded space and aeronautics programs are being severely curtailed. NASA's programs are critical to the U.S. aerospace industry, and that industry is critical to this country. We have an obligation to maintain the proper technological base. NASA should be the technological leader for the American aeronautics industry—it is our job, in cooperation with private industry, to focus on long-range technology needs for national and environmental security. Let me emphasize, however, that as defense spending for the development and production of new aircraft continues to drop, a gaping hole is emerging for the aeronautics industry. We must pay special attention to making sure NASA's commitment to one of this country's most successful industries is secure.

The High Speed Research and Advanced Subsonic Technology programs remain NASA's top aeronautics priorities, and our FY 1995 budget reflects this by continuing to ramp up funding according to plan for these important efforts. With respect to the National Aero-Space Plane (NASP) program, NASA, in partnership with the Air Force, is committed to completing the ongoing NASP technology development phase in FY 1994. I am pleased to report that, consistent with the urging of many Members of Congress, NASA and the Air Force are initiating an affordable hypersonics technology program. This partnership will maximize available resources while minimizing overall risk so as to conduct flight and ground test experiments within a reasonable timeframe.

Third, we are facing the challenge of making civil service cuts. We have committed to reducing by 1999 the civil service staff levels by more than 3,000 from where we are right now. But we plan to do so through retirement and other non-coercive measures. A reduction in force would be devastating to NASA and should be avoided. It would demoralize the Agency and hurt our efforts to diversify. But, we can only take a humane, non-coercive approach if the Congress enacts a timely buyout plan. Your support for this legislation is urgently needed.

Lastly, we are facing a challenge to the morale of the NASA civil service and our contractor workforce, given the continuing assaults on the Agency—not only in terms of uncertainty about the Space Station but also on our abilities, our intentions, our character. Over the last few years, we've had tremendous successes, and I want to set the record straight on that:

In 1993 alone, we delivered dramatic results. The Space Science program delivered an enormous volume of data and discoveries about the planets, stars and the cosmos. Data from operating spacecraft yielded discoveries about the origins, evolution, composition and structure of the universe. Even before the repair of the Hubble Space Telescope, the satellite had made some remarkable discoveries, pro-

viding measurement precision and detail to astronomers that had never before been possible.

NASA continued to lay the foundation for a future supersonic airliner and continued to work to make tomorrow's aircraft and the nation's air traffic control system safer, more efficient and more cost-effective.

The Space Shuttle conducted seven missions, proving its versatility once again, as it deployed and retrieved various payloads, served as a laboratory for scientists and researchers and acted as an orbiting repair station for satellites.

We continued to increase diversity within our ranks as well as expanding our involvement with small disadvantaged businesses and women-owned businesses.

We set a significant new course in the way we do business with the establishment of the Office of Advanced Concepts and Technology. Through this office, we are actively pursuing the transfer of our technology into the private sector, where it can boost U.S. competitiveness, spur new industries and create new jobs.

NASA has never run from a challenge, and today is no exception. Reducing the deficit, meeting urgent new national needs and discarding old habits are all important to America's future. This budget plan is a sound one, with reductions that still preserve a meaningful space and aeronautics program. But this is it. We can't get any closer to the bone.

Just from a sheer stability standpoint, this Agency cannot afford any more cuts and deliver to the American people the benefits of a balanced program. Based on what we know today, we cannot cut human space flight any further. We certainly cannot eliminate it. I will not support a program without human space flight, and the American people will not support it either. That is not a space program.

The Space Station is held at $2.1 billion, and there is no room for additional Shuttle cuts. As for aeronautics and space technology, we've made a commitment to the future. Technology is having a real impact on our quality of life and our ability to compete in the global economy, and cuts here would be a terrible mistake. Our technology programs are vital. They will result in technology transfers that benefit and touch the lives of all Americans—from spinning off new industries like commercial remote sensing to improving treatments for burn victims and heart disease.

If there are more reductions in FY 1995, they will upset the balance and the quality in the program we have worked so hard to develop, and we will no longer be able to say that we have a program that makes sense for the country. We absorbed an 18 percent cut in real terms in the five-year FY 1994 budget submittal, and a 12 percent cut in the five-year FY 1995 submittal before you today. That's a 30 percent cut in the NASA program in two years. We must hold the line at this level.

We have absorbed these large cuts and we have reshaped ourselves to do business in a new way. It has been something like turning around a gigantic jet aircraft, speeding along at Mach .8. An aircraft that size and speed has tremendous momentum—it rockets toward its destination on an unerring path. To turn it around, to set it on a new course, takes some time. We are doing that. We have made some painful choices and our programs are stronger because of it.

There is no place for any more reductions. We've stepped up to the plate again and again for our share of budget cuts and we simply cannot endure further reductions and maintain the balance we've worked so hard for, or be meaningful to the nation's goals.

It is time to decide what we want from the nation's space and aeronautics program. Do we want mediocrity? Do we want to keep eating the seed corn? Do we want technology that never leads? Or do we want a real, live space and aeronautics program? One that is on the cutting edge of technology development and transfer, scientific breakthroughs, the creation of new jobs and industries?

We are a can-do Agency. We have a strong space and aeronautics program that will better the lives of Americans. NASA's FY 1995 budget plan will enable us to make a real difference to America's future and the next generation. We need your support to continue to do great things, that inspire the world.

NASA FY 1995 Multi-Year Budget Estimates

[In millions of real-year dollars]

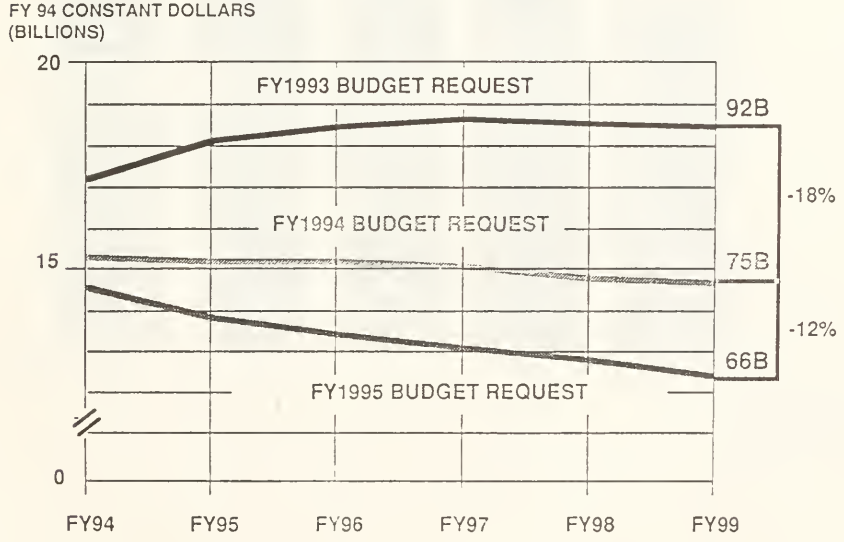
Fiscal year 1995 President's budet	1993 Past year	1994 Current year	1995 Budget year	1996 Estimate	1997 Estimate
Human Space Flight	$6,672.0	$46,069.7	$5,719.9	$5,594.6	$5,533.6
Space Station	2,162.0	1,937.0	1,889.6	1,833.6	1,782.0
Russian cooperation	79.5	170.8	150.1	129.2	111.8

NASA FY 1995 Multi-Year Budget Estimates—Continued

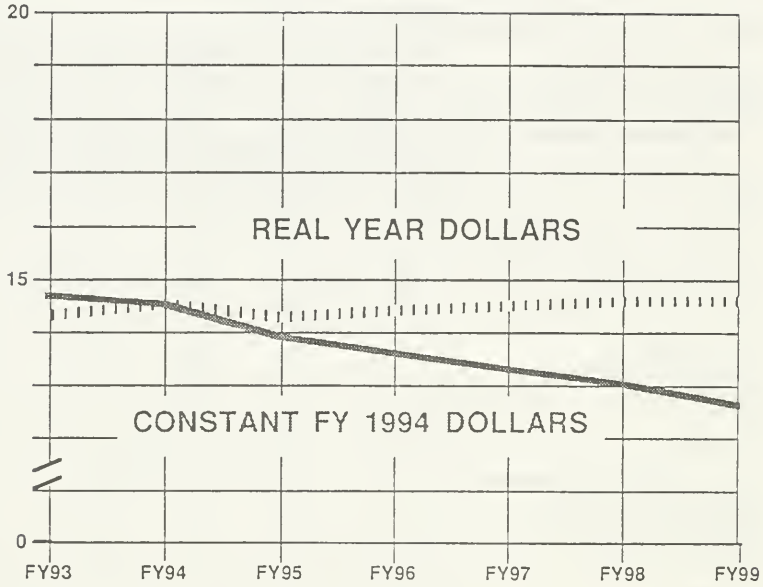
[In millions of real-year dollars]

Fiscal year 1995 President's budet	1993 Past year	1994 Current year	1995 Budget year	1996 Estimate	1997 Estimate
Space shuttle	3,88.2	3,549.3	3,324.0	3,295.7	3,316.5
Payload and utilization operations	442.3	412.6	356.2	336.1	323.3
Science, Aeronautics, and Technology	4,908.7	5,847.3	5,901.2	5,978.9	5,996.7
Space science	1,510.4	1,721.9	1,766.0	1,694.4	1,512.0
Life and microgravity sciences and applications	407.5	515.3	470.9	527.4	545.6
Mission to Planet Earth	936.3	1,024.5	1,238.1	1,271.1	1,308.2
Aeronautical research and technology	769.4	1,102.2	898.5	939.3	1,018.8
Advanced concepts and technology	464.9	495.3	608.4	631.3	692.3
Launch services	180.8	313.5	340.9	317.1	301.9
Mission communication services	546.5	589.1	481.2	486.6	499.9
Academic programs	92.9	85.5	97.2	111.7	118.0
Mission Support	2,727.2	2,619.0	2,662.9	2,810.0	2,952.7
Safety, reliability, and quality assurance	32.7	34.3	38.7	38.8	39.0
Space communication services	333.7	214.4	268.9	350.3	449.9
Research and program management	2,171.4	2,148.2	2,220.3	2,250.0	2,278.7
Construction of facilities	189.4	222.1	135.0	170.9	185.1
Inspector General	14.6	15.4	16.0	16.5	17.0
Total	14,322.5	14,551.4	14,300.0	14,400.0	14,500.0

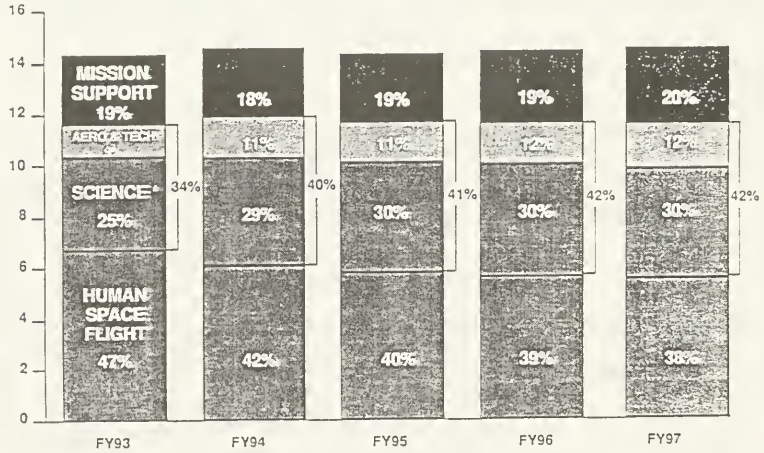
FY 1995 PRESIDENT'S BUDGET



BILLIONS OF DOLLARS

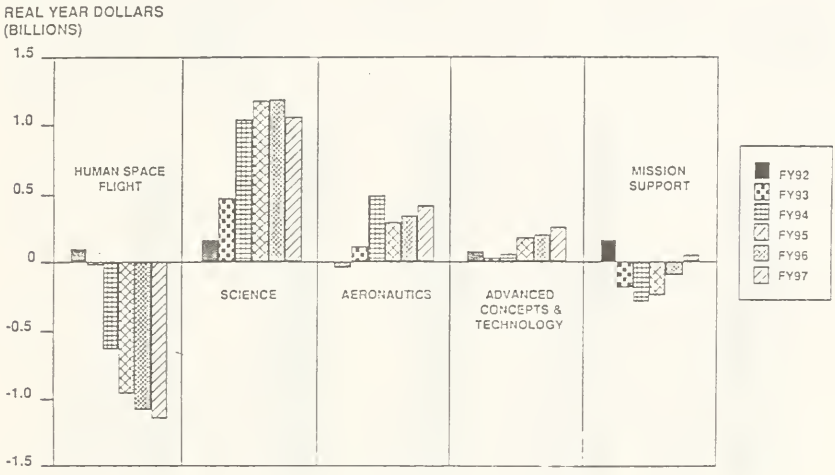


REAL YEAR DOLLARS
(BILLIONS)

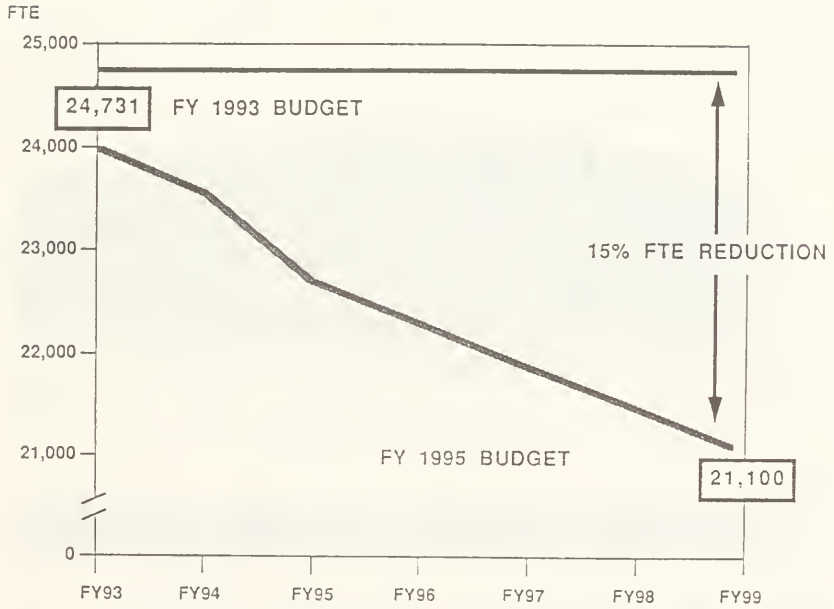


	FY93	FY94	FY95	FY96	FY97
*SCIENCE PROGRAMS	20%	22%	24%	24%	23%
SCIENCE SUPPORT (LAUNCH, COMMUNICATIONS)	5%	7%	6%	6%	7%

Changes From Fiscal Year 1991



CIVIL SERVICE EMPLOYMENT



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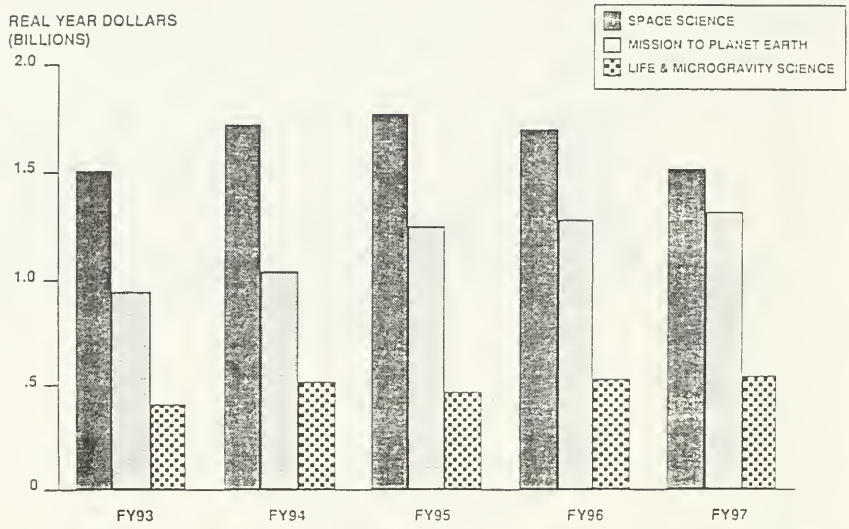
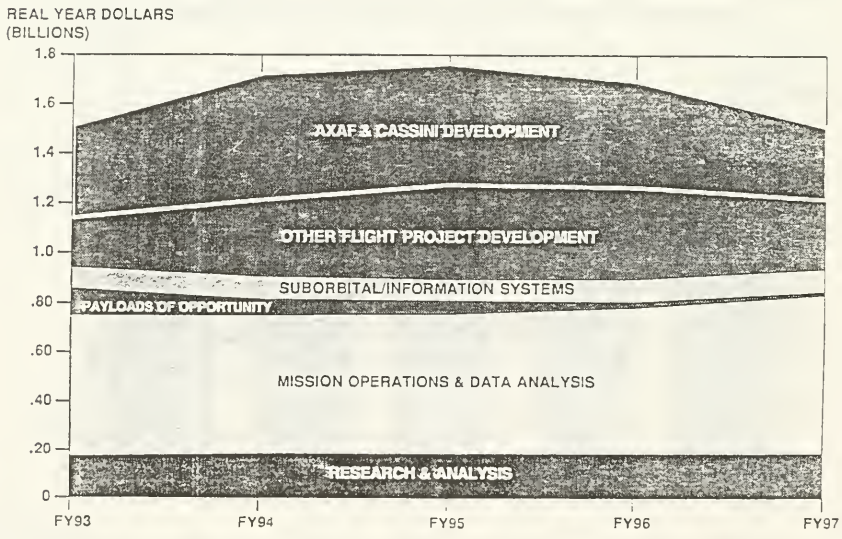
SCIENCE



SPACE SCIENCE



Senator ROCKEFELLER. Thank you very much, Dan Goldin. And I would yield at this point to the full committee chairman.

The CHAIRMAN. Just one question. The morale is still high even with these cuts?

Mr. GOLDIN. I believe as we undergo change there will always be difficulties. There will be some local problems with morale as we have to explain to people the issues that problems we have. But on the broad scope, I do think we have a good morale. It could be better and will get better as people understand the challenge.

Now, there are those who have individual interests and an intense desire to perform. And when one has worked on an activity for years in a given manner and it suddenly changes it can be difficult on the morale. And so I would not want to tell you that everything is perfect at NASA. Yes, we do have problems but we are working on it as a team.

The CHAIRMAN. We have not compromised any safety, I take it?

Mr. GOLDIN. Absolutely not. And, in fact, one of the issues that has come up is how do we manage safety, and one of the primary methods for managing safety is personal accountability and responsibility.

There is one human being at NASA that speaks to the safety for human space flight and that is Gen. Jed Pearson. He was instructed by me as we prepared this budget to establish where the threshold was on safety, and I instructed General Pearson the very minute we exceeded a limit on safety to stop and say, "This is it."

He has stated that this is a budget he is prepared to live with. But at the present time, knowing what he knows, he is not prepared to cut another nickel unless he can find an additional way of removing tasks that are not necessary.

The CHAIRMAN. Thank you, Mr. Chairman. I will take my turn.

Senator ROCKEFELLER. Two very important members of our committee have just joined us. Senator Burns is the ranking member, and Senator Hutchison. Do either of you have statements that you would like to make?

Senator BURNS. I would pass to Senator Hutchison for the time being.

Senator ROCKEFELLER. At this point it is just for statements.

OPENING STATEMENT OF SENATOR HUTCHISON

Senator HUTCHISON. Let me say at this point I am very pleased to be here with Mr. Goldin. I worked last year with him on this and I know you, Mr. Chairman, have done a lot of work looking at the space program and NASA and the Space Station, and are trying to make sure that we are doing everything in the most efficient way. And I think Mr. Goldin feels the same way, and I am pleased that you are here and look forward to working with you to make sure that we have a strong space program in the future.

Senator ROCKEFELLER. Dan, I think you and I both would guess that with the pressure on budgets, with a constitutional amendment to balance the budget by Constitution losing by only four votes—it might have been two, I am not sure. It was very close, and the vote was not taken until the votes to defeat it were there and we waited a long time. We went 1 week with only one vote.

So, that is the mood. In many ways, that is the obligation, and I think one can say almost a moral obligation to put our fiscal house in order. The American economy appears to be responding to that and in a very interesting way, I think, Democrats have bought into that philosophy, which is significant because it I think ensures that the budget is going to remain tough and times will remain hard, which in sense implies that NASA's budget over the next 5 years is not going to grow. It probably implies that we are talking about, you know $14.3, $14.4, $14.3 all of which, of course, means

that we are not talking about growth or even keeping up with inflation, nor even keeping close to that.

So, in answering questions about fiscal year 1995, my interest is just as strong and perhaps more firmly guided by the prospects of the next 5 years. And the statements that you have made with respect to fiscal year 1995 would be harder to make for a 5-year period under the same conditions, would it not?

Mr. GOLDIN. When I made my comments, I was referring not just to fiscal 1995, but the 5-year budget plan, which in real terms, when you include inflation, has the NASA budget going down in buying power by 12 percent, and so I was looking at the 5-year horizon.

Senator ROCKEFELLER. You include your statements to cover all of that?

Mr. GOLDIN. Yes, sir, and there is but one problem that we believe we have, and that is in the space science area. We were able to work out a fiscal 1995 budget that we believe addresses the key issues in space science.

We have said over the next 6 to 9 months NASA is going to work with the scientific community, and NASA is going to work with the industry community, and I have talked to 50 representatives of CEO's just in my office last week, and on Monday we are meeting with 50 scientists to work together to define how we will resolve what we believe to be $100 to $300 million a year problem within the space science budget.

One solves problems nowadays not by starting new programs, by building on top of what you have, but one solves problems nowadays by saying, "How can I do things better and different? One takes a look at operations budgets, where we have a large number of people absorbing a major fraction of our space science budget not building new spacecraft, but just operating them. We are looking at commercial practices, best-in-class practices, and we are going to see how we can get more with less.

Another thing we are doing is, we are not accepting the adage to do space science and astrophysics experiments one has to spend billions of dollars, and just 2 days ago we sent out an RFP to industry designed by industry where NASA is going to manage differently. We are going to have no more than two to four NASA managers managing programs built to industrial standards.

The commercial communications satellite suppliers know how to operate on a fixed-price budget, and we are going to set the requirements up front, and we believe we are going to have stunning new breakthroughs in terms of doing things in a shorter period of time for much less money. This is how we are going to resolve the issue of filling in some of the voids with space science, not coming back to ask for more money.

Senator ROCKEFELLER. I understand when people talk about technology leading to costsavings. It is far easier for me to apply that to the health care field than it is for me to apply that to NASA, and it does not readily occur to me—now you have Dr. Cordova at your side, but it does not readily occur to me how new technology saves costs in the NASA program.

Mr. GOLDIN. Let me give you a very simple example. When we designed our spacecraft and had a $1 billion spacecraft program

that was cast in for about 10 years, people were not willing to use advanced technology because so much money was involved it became a national priority, so they would use 10- year-old technology to assure that it would be safe.

Because they had to assure it was safe, things got overtested. The spacecraft weighed so much, instead of using the small launch vehicle we had to use a big launch vehicle. Because it was the last ship out of port for a decade, people would pile more and more instruments on it, because if they did not get an instrument on board that spacecraft, they would not fly for the rest of their careers.

So, we built the system that had a self-fulfilling prophecy of costing more, so instead of using advanced composites, instead of using advanced microelectronics so we do not have to have a number of people sitting—we have spacecraft today that are launched by NASA, in fact one is getting ready for launch, where we are going to have to have a cadre on the ground because we have a 10-year-old computer in the spacecraft.

So, I submit that although NASA is on the cutting edge of technology, because we have an approach where we wanted to guarantee success and we had megaprograms, we had a self-fulfilling prophecy it has to be expensive.

I come from industry, and I only came to NASA 2 years ago. We were using leapfrog technologies to build small satellites, satellites that had storage capabilities comparable to computers on the ground, so you do not need a cadre of people standing there. Our mission operations and data analysis account in space science is $750 million a year, which is more money than we are spending on developing spacecraft, so we have a guaranteed, if you will, entitlement program, because we are using old technology and having people on the ground operating the spacecraft.

So, these are the things that we have to do, and by the way, we are now finding in designing advanced spacecraft and building computer simulation models for the spacecraft the automobile industry is so excited about simulations that we have run for spacecraft we are transferring that software technique to the auto industry so they can drive cars on a computer before they go build them.

So, that is what happens when you go to the cutting edge, and we are prepared to launch satellites in 3 years instead of a decade, and in 1994, we started four programs that are no more than 3 to 4 years. It is a test everyone has to watch, but we submit technology is a paradox. You get more for less if you have the courage to use it.

Senator ROCKEFELLER. Dan Goldin, you had last year testified to us that when you come to a certain point in your budget—and it might have been you used below $14 billion, but that you come to a certain point that your budget is small enough that you can no longer say, "we will do more for less," or "we will do less more slowly," or "more and more slowly." You simply have to say, "we will stop doing certain things."

I want to know from you, and this is your chance to lay down your marker, at what point have you calculated that you would have to make a program deletion if we reach a certain budget number which is insufficient?

Mr. GOLDIN. Mr. Chairman, I would say with this budget, knowing what we know today, if we have to have any further cuts we are going to destroy the balance that we fought so hard to obtain.

Senator ROCKEFELLER. Well, go ahead, but the word "balance" is not satisfying me.

Mr. GOLDIN. Well, let me describe what I mean by "balance." Two years ago the human space flight program inside of NASA was 47 percent of the budget, and that was too large a fraction of the budget, so we worked to reduce the cost of the Space Station and the space shuttle, I mean, taking out billions of dollars, and in our 5-year projection, human space flight is going to be reduced to 30 percent of our overall budget.

We had not spent enough money on science. We have a commitment to understanding our own environment. You know, that very thin blue line of tens of miles is what allows human beings to live, and we are trying to understand human-induced effects, and in this budget we are increasing the amount of money over the next 5 years that we are going to spend to understand our environment.

We are increasing the amount of money we are spending in life and microgravity sciences because it is going to help us understand how humans can live and work in space and make more competitive biotechnology products and materials right here on the ground.

Senator ROCKEFELLER. Let me sharpen the question, then. My counterpart in the other body, as they say, has, I believe, indicated that if we go beneath $14 billion, that he will no longer support the space station. Now, that is the kind of question I am trying to put to you.

Mr. GOLDIN. Well, I will come back and say I am not sure whether that would be my first choice, but I do want to say that we would have to cut a major program. I would be concerned about saying right off the bat that the space station is the program to cut.

Senator ROCKEFELLER. I understand that. I am simply trying to sharpen the question. If we went below $14 billion—so far you have said, if we go below $14.3 billion, you will have to destroy the balance. At what point will you have to destroy a program?

Mr. GOLDIN. I am not sharp enough within hundreds of millions, but certainly I would agree with the statement if we go below $14 billion we will have to make a major program cut—a major program cut. We cannot maintain the programs we have today.

Senator ROCKEFELLER. So, one of them will have to go.

Mr. GOLDIN. Yes. I would not at this point in time say it should be the space station, but I want to make another statement here, and this is where my big concern is coming in. In the last 11 months, NASA stepped up and in two increments reduced our budget by, first, 18 percent over the 5-year period, and then another 12 percent. This has been an enormous undertaking. It has a large number of people involved, and it has caused an enormous dislocation.

My concern is this: what does America want from its space program? Let us say we were to reduce the budget another $500 million, which is a number commonly heard around Capitol Hill. Next year we will come back, and we have a new level to establish, and there will be another little $500 million cut from the White House,

and another $500 million cut from the Congress because domestic discretionary spending is going down.

At some point in time, it is not just a question of what program do you want to cut, it is a question of what does America want from its space program, and as a society what do we want to put in the investment account?

If we view the space program as a place where we resolve domestic discretionary spending problems—and if you take my scenario we will be down to $7 billion in 5 years, and this is an issue that is terribly concerning to me, and this is an issue which says to me, I believe that we have got to have a discussion about the broad space program and not say, we will just cut this little piece out or this big piece or that big piece.

Either America believes that the space program is crucial to future generations, or it is not, and I am terribly, terribly concerned about the trend. This is why I came and I took this job, because I believe that we make a very small investment in the future. We do not value at a high level in our society things that have a decade or a two-decade payoff, and it is very easy to say, well, let us cut it now because we have to survive, but life is more than just survival.

Our generation has lost its ability to dream. When a civilization loses its ability to dream and have a vision and invest in the future, I worry about us as a civilized society.

I was just out in Wichita, KS, last Friday. Twenty years ago America decided that we did not have to focus on general aviation. We were not going to invest a nickel in it. In 1978, we built 18,000 planes and had a net positive balance of trade of $300 million in general aviation.

In 1992, we sold—or 1993, I think we built 899 planes. We had a net balance of trade, negative, of $800 million, and single engine piston two-place planes that are used for trainers for all new pilots in America are being imported from France—America, where we built the aviation industry.

Now, at the time it was a very easy decision to make, because we did not know where the payoff was going to be, but I went out and I talked to the workforce out there. I met with the people that build the planes. I met with the people that design them and are the CEO's. We cannot have this. We have 17,800 airports in America, and there are more general aviation planes being sold in China than in America.

So, you will not see the impact of ratcheting down the NASA budget $500 million each year today or tomorrow, but 20 years from now we may wake up and we may not be competitive as a society, because there are very few investment accounts in the Federal budget that look out decades.

Another example I will give you—because NASA is investing today in the high-performance computing initiative, and in this budget it is going up. It is going up from about $80 million a year to $120 million. The tools that our society is going to need 10 years from now for the most modern health care information systems which should save the Nation tens to $100 billion from recent estimates, they will not be there.

Now, we will go into the budget and we will say, well, let us trim a little here, and trim a little there. We have to decide what we stand for as a society, and at some point in time, future investment has to be a priority. I feel deeply and strongly about this, and it is more than this $300 million.

Senator ROCKEFELLER. Let me yield to Chairman Hollings.

The CHAIRMAN. I do not mean to get ahead of the others, but you are right on to whether we—what does America really want? I can tell you. They want it all. You said they have lost their ability to dream. There is one permanent dream they have, and it is still a free lunch. They want all of these programs.

So, it is not a question now that the Congressmen and Senators face with whether they really, truly value the space program.

I do not want to cut too much. In fact, I recommended a value-added tax to pay for some of these things. But when I look over here at women's, infants', and children's feeding, funded at only one-half, I look over here at Head Start, only one-half, I look at my health research, and I have not employed a graduate research physician out at NIH in 10 years.

Then I come to Dan Goldin's space, and I am saying, wait a minute, are we really attracting the best and brightest to the space program as astronauts? They are cutting back and cutting back and cutting back so much that they will say, "Well, we do not want to join that sinking ship."

Is the scientific community really looking and saying, we had better get into some other kind of science, because space is cutting back? Is the industry community doing the same thing? I think we have already reached that peril point, Dr. Goldin, that is what bothers me.

That is why I said before we venture out onto the space station, and voted against it, I said, let us keep what we have got and fully fund it, and—it was just an appropriate time rather than coming in later, Mr. Chairman. I appreciate you yielding.

But I like that enthusiasm, and I like that vision, and there is no better presenter of the space program than yourself, but we have got to be honest in our presentation, too. It is not what we want or what America wants. They want it, I can tell you that, but they do not want to pay for it.

So, there is the dream of the free lunch. They want that program, that program, they have no idea what to pay for it, none whatsoever, and we still are fighting that, and I have not given up. I have gone to the extreme of, you know, recommending taxes, but we vote for all the cuts and we hold back on new programs.

Oh, I would like to have volunteerism. They called me up from the White House and said, look, I helped start the Peace Corps, so I know all about volunteerism. The fellow says, well, we have got 2,000 out there volunteering in the flood, and I said, son, you have got 2 million not in your program volunteering.

You do not have to worry about—I mean, the Congress in Washington, the Government, thinks we invent competition, we invent volunteerism. Man, the country is full of it, but they do have a dream. They do not want to pay for any of it—none of it, I can tell you there for every one of the programs.

So, that is what you have got to realize in making up your budget, is not to cut back here so much, because I want a space station and I want this program and I want that program, and yes, you as an appropriate administrator saying fine, we have got all the programs, but then you cut back into the real heart and guts of your program, so you lose your morale, you fudge on safety, or you are cutting back so much you do not attract the best and the brightest in the industry, the scientific, the astronaut program, to your program.

Mr. GOLDIN. Mr. Chairman, I share you concern, but let me tell you how we approached it. Last year we did cut programs. We eliminated programs. We were going to have a program called TDRS–2, where for billions of dollars we were going to buy a follow-on generation in communication satellites. We eliminated that. We eliminated three or four other programs that represented a very major, big wedge.

But there is another thing that NASA had to do, and NASA had to figure out how to operate much more efficiently. I do not view that as something bad. I view that as something very positive.

I come from industry where we downsized over the last 5 years, so while we were downsizing in industry and learning how to do more with less, the NASA budget kept going up, and we now have come to a point where we, NASA, together worked with our contractors and the people in the universities to downsize the budget, and we believe we have a very tough budget.

I would not argue that it is easy, but let me say, safety, we do as hard a job and tough a job as we can, but eventually we do very risky things, and there always is a risk that there will be problems with a program. We could never guarantee 100 percent success. Risk is a part of our business.

With regards to human beings of high quality, in the last 3 or 4 months we have had some of the most brilliant people from universities, and industry, and the services, come join NASA. Dr. Cordova is among the best in the country. Dr. Charles Kennell, a distinguished physicist at UCLA, came to NASA to head up the Mission to Planet Earth Program. We are going to go out and have applications for new astronauts. We have thousands of people that have expressed an interest.

NASA does difficult things. We need to do difficult management things in addition to doing difficult technical things. We should not do easy things, and we will have failure, but we will make progress. We have a program where we trim the weeds. We eliminated the things that we believe are necessary.

Let me also say there are things we did not need. We had 19 service support contractors doing our graphic arts work in Washington. There was no need to do it when we have desktop publishing and each of us could do it ourselves. We had huge overlaps between centers. We have had facilities operating for 30 years that are not working on high-priority things, and so within our budget we prioritized the facilities we needed and we are closing them.

Let me tell you, one does not win popularity contests for doing that, but I believe we have a healthier, stronger NASA, and morale will come around, and we do have a lot of people dedicated to stepping into the future.

Senator ROCKEFELLER. Senator Burns.

Senator BURNS. Thank you, Mr. Chairman. And, Mr. Director, it is nice to see you this afternoon. And we understand that not all life is a piece of cake here.

Yesterday, Chairman Rockefeller and I introduced a bill that provides the framework for NASA to move in a direction, maybe more businesslike approach to aerospace and the industry. And I asked you about this on the telephone and why I think we can accommodate you and work together on this thing to make it work. And I think it does a couple of basic things. In NASA it gives direction to its technology investment and requires the United States to prepare a strategy for developing world class aeronautics testing facilities.

I am a little bit concerned whenever we start going to the well on doing some R&D work that we are taking away some of the R&D which I think should be done in this country and the investment should be made in this country in the infrastructure, especially in the concepts of air tunnels and this type thing. I have been working with MSC on Butte, MT. We think that we have something to offer out there, and we would certainly enjoy your support there.

I am also wondering how serious is NASA looking at our civil high-speed transports and our civil aviation.

Mr. GOLDIN. Senator Burns, I am very proud of that program, and this is a perfect example of how NASA is doing things differently. We were asked by the President after he made a trip to Boeing, just after he assumed the Presidency and met with the executives of American aviation and aeronautics industry, to establish a relationship with them. So, we went to the industry and we asked the industry to define for us what were their priority needs and what did they think the program ought to be. We then went to the National Academy of Engineering and asked for their support to help understand how to work the priorities and the funding.

The industry and NASA and the National Academy of Engineering worked together where NASA viewed the industry as our customer. Because there are 1 million cutting edge jobs in aeronautics it is the largest manufactured export of the United States of America and among the highest technology products we have. The program you see in this budget for the high-speed civil transport, the Advanced Subsonics Technology Program—and the Hypersonics Program represents what the industry told us they wanted.

Now, part of the problem we had was we had to live within a given funding wedge. And the National Academy of Engineering criticized NASA for having most of the work done in-house. For a long time, many NASA researchers felt it was more important to publish a report at an international conference and not get the data to the aeronautics industry than to say to the aeronautics industry you are America's customer, what can we do to make you competitive? And we took the money out of the NASA infrastructure.

Not a penny came out of the budget that went to the industry. And in fact, instead of 60 percent being done at NASA and 40 percent being done in the industry, 60 percent of the work is being done in the industry, 40 percent at NASA, and we have eliminated

service support contractors that were providing administrative support to the NASA people. The remaining NASA people are now working on advanced technologies that will even leapfrog what we are talking to the industry about today.

This is an outstanding program, and I challenge you to talk to any major executive in the aircraft industry in America, and they will tell you it is their program. And this is going to make America competitive in the next 5 years.

Senator BURNS. Now you think you can—in other words, do you think that we have a pretty solid bond between the private companies and the work at NASA?.

Mr. GOLDIN. We believe so. And in fact, as Administrator I meet with the industry twice a year, and tomorrow afternoon I am going out for a major meeting with the aircraft corporations along with Dr. Wesley Harris who is head of the Aeronautics Program so we can sit and listen and have the industry constantly update us. But in our budget we did not cut money from the program areas. We cut money out of the NASA infrastructure.

Senator BURNS. Well, I was wondering. It looks like you have got about $3 million, an outlook of $3 million outlays in the next I think 5 years for wind tunnels taking anywhere from mach 1½ or therein kinds, but I am also kind of concerned about our going higher than that, or higher airspeeds—mach 22, mach 23, 25. But those hypersonic programs have been sort of put on the shelf for the time being. And should we be doing some work in that area for when that does come off the shelf and become a vital part of NASA?

Mr. GOLDIN. Let me say this: This is an area where I think Senator Hollings had a legitimate concern that we are spending too much money. Now, there are a lot of wishes and promises on a program called NASP. It is we could have, we should have, we would have, and $1 billion program was suddenly becoming $10 billion, and that is another program that we canceled, sir.

Now, we did not eliminate hypersonics research. We did not have the data necessary to go build an experimental plane. So, what we said is let us crawl before we walk and walk before we run, and let us see if we could build a scramjet that operates at mach 7 in a wind tunnel on the ground. After we do that, then let us take some old ballistic missiles and launch some scramjets into space and see if we could operate them at mach 12 to mach 14 so in effect you build a virtual wind tunnel in space using existing assets. And then let us see if we could understand some of the flight control problems using existing launch vehicles.

I submit over the next 5 years America will learn more about hypersonics without having a huge program office and lots of bureaucracy and lots of reports, doing things in a much smarter manner. Quite the contrary, I believe we have a stronger hypersonics research program today than we had before.

Senator BURNS. Well, we are sure willing to work with you on that and in areas, especially when you have got some infrastructure that is prepared to make some investment, in order to accommodate those areas of your work as far as NASA is concerned. I am also supportive of visiting with Vice President Gore and the Space Station and this type of thing. So, we will work very closely

with you, and I realize that when you come into a time—come into a situation where we are going to have to do more with less, we also understand that.

I just got a note handed to me. I mentioned it this morning. There was a question I am wondering if you are really worried about. We have been sitting in Washington, DC, here all winter, and the worry about global warning. Has that escaped you? [Laughter.]

Mr. GOLDIN. No, it has not. No, it has not. And in fact I would like to share an experience with you. The administration is working with the automobile industries, and I sat on the south lawn of the White House and Vice President and chief executive officers of America's automotive companies. And they picked off a program called the Clean Car Program, and now I believe it has a new name. And to motivate the engineers that are working on it the Vice President invited them to the Smithsonian, to the Air and Space Museum, and asked those people to watch the "Blue Planet," which is just an incredible film about our environment. And then he showed them some curves about the CO_2 count and concentration in the atmosphere. And it was really an incredible chart.

We have to understand where the sources and sinks for carbon dioxide are. We have to understand the influence on the environment. And we have set up a very careful program that is going to take a few decades so policymakers such as yourself could make decisions based on facts and not emotion. And I want to point out if you go back 20 years when people first discovered that there was a problem with the ozone area and there was a hole in the ozone are over the Antarctic NASA was there with our planes to not just say there is a hole in the ozone layer, but in a systematic way over a decade we were able to understand the chemical reactions that took place that caused the depletion of ozone. As a result of the work we did we had the Montreal protocol, and that was a policy decision based upon knowledge.

That is exactly what we plan to do with Mission to Plant Earth, so the policymakers of the future will have facts and not emotion. And this is a program in spite of the declining budget over the next 5 years that we prioritized and said this must have an increase. And that is more than we can say for the Human Space Flight Program where we took an 8- to 9-percent decrease over this time period percentagewise and in total dollars measured in billions.

Senator BURNS. Well, the reason I asked you about that is I think some of us at times seem to forget about the spinoffs that have helped this society, this American society, from not only the aerospace, the space—what we have done in space and the technology we have gained there and the technology that it took to get us there, and also the aeronautics programs.

I might ask you at this time in order for the American people—I agree with the chairman of the committee, Senator Hollings, people want it. But they do not want to pony up the money. And there is only so much of it coming into this town and we have got to put it where we think it will do this society the most good. And that is where we should make those investments. I do not know of a program where there is more spinoffs to the benefit of this society than what we have enjoyed out of the space program to date. And

I would hope that we could continue on with that, both in space and in aeronautics, as we move forward.

But the chairman is exactly right. He is right on target when he says that we go home, and if you ask anybody in any crowd to put your hand in the air, how many people really support a strong space program, every hand will go in the air. Now, if you ask them, OK, now it costs so much, now you are going to lose a few hands in the air.

What we have got to do is we have got to tell the American people just exactly what those spinoffs are, and I would suggest to you maybe we should start putting out a list, hands on, things you can touch that have helped this society to be more efficient, not only in industry, but I mean every little thing that we touch in our houses nowadays that is as a result of a very active aerospace and of course aeronautics program.

Dr. CORDOVA. Senator Burns, may I comment on that? We are engaging in a very active effort at NASA in collaboration with the White House and other agencies, but especially for ourselves at NASA, to do this very thing. We are looking deeply at our programs, especially in the fundamental sciences, and where that has benefits to the Nation, and we are drawing up those pieces, those arguments, so that we can cogently bring those benefits in a very articulate way to the people. So, we do have a program that is underway.

Mr. GOLDIN. Senator Burns, I would like to add two other thoughts to that. First, I would like to say that the benefit potential is phenomenal, and let me just give you a few figures. Through the year 2010 there will be $800 billion in new aircraft sales worldwide. There will be $250 billion, or one-quarter of a trillion dollars, potential in sales if America could be first to the market with a clean nonpolluting quiet efficient supersonic transport.

In and of itself that is an area where we could have a much bigger impact on the Nation than any of the investment. But let me keep going.

As we had tools before, NASA developed error-free software. We were the only agency in the world that had to do it, because we had to send people to the Moon, and you cannot send people halfway to the Moon. You have to send them all the way there and bring them back. Our error-free software is the grand daddy of the digital communications systems you have today with its software, and even if you go to the ATM and the bank as we speak today under the high-performance computing initiative where we are designing software packages for understanding atmospheric environments and on Mars, where we are flying aircraft in wind tunnels, we are developing computer tools that Detroit, that Boeing, that McDonnell Douglas will be using 10 years from now.

And let me also say that NASA has been approached by the major corporations in America interested in health care information systems. It is a program called HOST. These companies believe that by applying new generation information systems where we get this data out of the Space Station, the distributed data analysis from Mission to Plant Earth, we are talking about a potential savings of $100 billion over 8 years for health care. These are corporations that are huge. I was out at Sprint in Kansas City. They

are interested. There is a consortium in West Virginia of a number of health care providers. They are involved. These are companies with sales $10 billion and more. And NASA is there with this technology.

Now, let me say it is quiet. When you see a rotting infrastructure with roads and bridges and tunnels, everybody knows because they see the potholes. But America's technology infrastructure is rotting, and we have got to make an investment. And you go through all the Nation's programs and I think you will come up with very few like NASA that is always there 10, 20 years ahead. So, this is a silent death that our infrastructure is having, and NASA is right on the edge.

We are pushing computer speeds in order to design aircraft and go to planets and operate a space station. We cannot live with computers as they are, and we are pressing the computer industry to their limits. Right now, they are at a measure of 1 billion operations per second. We want 1 trillion, and we just signed up to that and we did a recent study which says we need 1,000 trillion or maybe 1 million trillion operations per second. These are the tools that your children are going to use. But if we start cutting back we are going to lose these opportunities. This is essential.

And again, there are other aspects. What do we stand for. Who are we as a people? We have got to do things other than survive. We could feed people. We could provide housing and the means to do those two things. And as a society, if we build couch potatoes we are not going to get there.

When they did a survey of children that were interested in math and science there were two things that motivated those children. No. 1 was Star Trek and No. 2 was astronauts. When I go to places, not Washington where you have cynicism, but I go to Butte, MT, and I go to Kansas City and I go to Nashville, TN, I do not have to apologize for the space program. People actually stand up and applaud when I talk about it.

So, I contend that this is an integral part of our Nation, and if we keep cutting it back we will survive. We spend $14 billion a year out of $1.5 trillion as a Federal program in a $5 trillion economy. Do we want to sit in the grandstands and see other nations in space making opportunities for their people while we could not afford $14 billion a year? And let me tell you, the NASA program, if left untouched, in 1995 would have been somewhere around $19 billion. In 2 years we turned that around and now we are arguing whether it is $14.3 or $14.0 billion.

I think that the industry has done an unbelievable job, and I will stake the space industry and NASA against any agency. Show me an agency that cut their budget 30 percent, 30 percent in 11 months, and did not whimper a cry. We are responsible, and we are going to create opportunity for this country.

Senator BURNS. Well, I think you will always have an ardent supporter in me, and I think with the bill that the chairman of the subcommittee and I have introduced I would hope that we could work together on that and we could find a better way to, let us say, build the mousetrap and get the partnership of private industry and NASA, because I think the chairman has a tremendous idea

and it needs exploring. But we also need your support in how we make it work for the betterment of both this Government and us.

But we will sure support you, and I would like to see that we get together on some hypersonic research, and it may be minuscule right now. But I think it is something that we have to work on and we have to keep it alive, because it is coming. And as long as we have got something out there working in our infrastructure we can also apply it.

So, I thank the chairman for this opportunity.

Mr. GOLDIN. We will continue to work with you. We think your bill makes a lot of sense. We have a few minor details that are of concern, but in the broader sense we salute the bill, and we are spending between DOD and NASA $85 million a year over the next 5 years on hypersonic research. We think with this money we could take the Nation out ahead of the world.

Senator BURNS. Thank you very much, and Mr. Chairman, I would ask unanimous consent that my full statement and Senator Pressler's be entered in the record.

Senator ROCKEFELLER. Of course, they will be.

[The prepared statements of Senator Burns and Senator Pressler follow:]

PREPARED STATEMENT OF SENATOR BURNS

Mr. Chairman, I want to thank you for holding this hearing on NASA's budget request for fiscal year (FY) 1995. NASA's $14.3 billion request is historic. It marks the first funding decrease requested by NASA since the end of the Apollo program in 1974. With the increasing emphasis on reducing the federal deficit, it is refreshing to have an agency request less money than the current funding level. However, the requested budget cut has prompted some concern about whether NASA has enough funding to support all of its civilian space responsibilities. Nevertheless, in general, the request appears to offer a balanced space program.

As a supporter of Space Station, I am encouraged that Space Station is fully funded at $2.1 billion. I believe that Space Station represents the kind of bold challenge that NASA should be doing. More importantly, if past missions are any indication, Space Station will produce significant breakthrough spinoffs that will ultimately boost U.S. competitiveness and create jobs.

Mr. Chairman, last year, we had a hearing on NASA's relevance to the U.S. economy. In my view, no NASA program is more relevant to global competitiveness than our aeronautics program. It has been one of the main factors in our continued world leadership in aerospace.

Yesterday, Chairman Rockefeller and I introduced an aerospace bill that provides a framework for NASA to move in the direction of a more business-like approach with the aerospace space industry. The bill, the National Aeronautics and Space Administration Technology Investment Act of 1994, does two basic things: gives NASA a direction for its role in technology investment and requires the United States to prepare a strategy for developing world class aeronautics testing facilities.

It is important to support our aerospace industry because of its key role in offsetting deficits in United States trade with other countries. One of the areas the industry lacks is adequate facilities to test new concepts.

My work with MSE, Inc., a company in Butte, Montana revealed to me that the United States does not have adequate wind tunnels and must rely on foreign wind tunnels for our nation's future High Speed Civil Transport in the short-term and a National Aerospace Plane in the long-term testing. Our aerospace companies' reliance on these foreign wind tunnels could result in advances to other countries' aircraft competing directly with United States commercial aircraft.

In the fiscal year 1995 budget. I see that the request contains no money for new wind tunnels that will be needed for developing any next-generation aircraft. Just last week, an industry-led task force called on NASA to revitalize its aviation research program by, among other things, providing wind tunnels. If we do not have money for new wind tunnels, we may have get creative and look at converting existing facilities to meet those aviation research. As you know, I am very interested in

exploring whether "MHD" technology can be used in conducting some of that aviation testing and I'd like to follow up on that here if there is time.

Despite the importance of aeronautics research, the budget request cuts the aeronautics budget by 18 percent and folds the National Aerospace Plane program into a generic research program.

I realize the need to reduce federal spending. But, to risk a $460 billion commercial space plane market (NASA's estimate) to save $220 million may not be a good idea. The fact is that for the last forty years or so, the return on NASA's high tech spinoffs has exceeded the government's investment by a great deal. Think of the impact of micro chips, computers, weather satellites, composite materials, to name a few, have had on our nation's economy and quality of living

Since the Wright Brothers flew their plane at Kitty Hawk nearly 100 years ago, the United States has dominated the field of aeronautics technically and commercially. We should not forget that the federal government was a major player in this achievement. Commercial aviation was fostered by using the U.S. Army to introduce air mail. The National Advisory Committee on Aeronautics (NACA), NASA's predecessor, solved virtually every scientific problem associated with aircraft either in its own laboratories or in collaboration with industry and universities.

The long line of Douglas Aircraft beginning with the DC 3, Lockhead's Constellation and the Boeing flying boats were greatly influenced by the NACA work. In the early 1950's the federal government helped industry and the NACA recruit top German aeronautical scientist and engineers. Working with industry and the NACA, these experts helped to develop military jet engines which were quickly adopted by the commercial aviation industry.

The Boeing Stratocruiser and later the Boeing 747 were adaptations of Boeing's bomber aircraft designs with help from the U.S. Air Force. In all these instances the return to the government in terms of jobs, foreign balance of payments, taxes and the improved quality the American peoples lives more than compensated for its investment.

I think it is important to continue this long standing partnership which is good for everybody. I applaud President Clinton for helping clinch the recent major aircraft sales to Saudi Arabia. I urge both the President and NASA Administrator Goldin to continue to pursue our current strategy on the High Speed Civil Transport and to keep an open mind about a long term strategy for a National Aerospace Plane.

Finally, Mr. Chairman, I am pleased that the budget request contains $76 million for NASA's portion of the High Performance Computing and Communications Program. I believe that this effort will be of enormous benefit to the public. For rural states like Montana, the program holds the promise of improving the quality of life for people in remote areas through advanced technologies like telemedicine and telecommuting.

Mr. Chairman, thank you again, and I look forward to hearing NASA Administrator Goldin.

PREPARED STATEMENT OF SENATOR PRESSLER

Mr. Chairman, as a supporter of NASA, and particularly the Space Station and the Mission to Planet Earth, I am concerned about NASA's proposed budget for FY 1995.

I look forward to hearing NASA Administrator Goldin's explanation of the joint U.S.-Russian cooperation on the Space Station. Those of us who support the Space Station have reservations about the reconfigured program. I hope Mr. Goldin can reassure us that NASA's funding request, and the design of the Station program, are sound.

One of the important elements of the Mission to Planet Earth mission is retention of the Landsat program. Senator Rockefeller and I were successful in obtaining a transfer of $90 million from the DOD FY 1994 appropriation to NASA for continuation of the program. I understand that NASA is working currently on a plan for the use of these funds. I hope Mr. Goldin will be able to give us a sense of NASA's deliberations on the proposed Landsat plan.

I have a word of caution, Mr. Goldin. Landsat's supporters in Congress look to you to retain a cost-effective Landsat program. Some preliminary estimates I have heard for construction, launch and operation of Landsat 7 are far too high.

I trust you will devote your attention to this plan and ensure the estimates for Landsat 7 are supportable.

Thank you, Mr. Chairman.

Senator ROCKEFELLER. Senator Hutchison.

Senator HUTCHISON. Thank you, Mr. Chairman.

First of all, I want to say, Mr. Goldin, that you really have bitten the bullet I believe and worked with the administration in the redesign of the Space Station. And I think you are doing a most responsible job. But it really is an important argument that America must be able to dream. And it is not just to have dreams that do not mean anything, but it is so that we can invest today in the technologies that create the new industries that will create jobs in the future.

The reason that America is the land of opportunity is because we have made those nugget research investments that have created the vibrancy and the vitality of a growing economy that creates new jobs that absorb all the people who come here. And when the real chairman who left, excuse me, Senator Rockefeller, says that we have to compete with the other kinds of very important programs, that is where I depart. Because I think we have got to segment our budget so that we do have a budget for the human needs that everyone agrees we must cover.

But that must be a separate budget, like I think there should be a wall on the defense budget, from the nuggets of investment that we are going to make for future vibrancy. I mean, we can eat our seed corn, and then we will be a country that is going into a decline in the next century.

If we plant the seed corn, then we will have those jobs for the future. And I think that is the comparison that we have to make when we are looking at the scientific budget. So, I applaud you for being realistic in the dreaming field and saying, yes, you are going to take your fair share. In fact, you have taken more than your fair share. But we have to put a wall around research and say, this is a priority.

So, I hope that as we go forward that that is the context, rather than continuing to take industries like the general aviation industry that you mention, which has been a terrible loss for America. We are the leaders. We did make the first airplane, and we have perfected it. And we should be the country that has the jobs from general aviation. And we have decimated that industry.

I heard all the arguments on the SSC, where we compared SSC spending with the social spending. And you cannot make the comparison. That was a $16 billion investment for a $100 billion return for the jobs that would be created in the future. And now that we are walking away from that, some other country will do it. And they will get the technology and the jobs. That is not what made America the great country that it is.

And I certainly am going to do everything I can to make sure that we do not do that to our space industry and our space research.

Let me be a little more specific now, and I will stop my monolog, and ask you, first of all, about our relationship with the Russians. I think you were very innovative, as was our administration—I will give them absolute credit for wanting to do the joint venture with Russia. But we also now have concerns about the stability of Russia. Where do we stand on that? What will be the gain that we have for our program from that? And are they good for their part of the bargain?

Mr. GOLDIN. I believe that that is a very important question. Let me provide a little background to where we were and where we are. We have a program of planned engagement that keeps increasing with time with the Russians. The first step of that program was to fly a cosmonaut on the space shuttle. The second step was to fly an astronaut on the Soyuz and to put them on the Mir vehicle. And Bonnie Dunbar and Norm Thacker just took off for Russia to get ready. We flew the cosmonaut.

The next step is to rendezvous the shuttle with the existing Mir station. And the step after that is to use some American technology to upgrade the solar arrays, and use the shuttle, which is the only machine capable of taking up cargo and down cargo, to orbit and back to help the Russians refurbish their Mir station so it will last until 1997. Then to have a number of missions to the Mir. Then to begin to engage by launching the Space Station in late 1997, and completing it in 2002.

We have decided it is in the national interest of America to engage the Russians in a positive way. For 50 years, the Russians have been isolated from us, and I am one of the cold warriors. I am proud of what I did, but that was in the time of the cold war, and I believe led to America's strength.

The President has decided it is in the national interest to proactively engage the Russians. And the Russians told us they want to participate in the Space Station. They accept the fact that it will be a U.S.-led Space Station, where we are responsible for command and control and for the management.

They are working with us, and I might say, the first piece of hardware that we got, in spite of the all the turmoil in Russia, was the docking mechanism, which they delivered to us on time, and it looks like it is outstanding. The Russians have 49 launches last year. We had, I believe, 28. I mean civil, military, and commercial.

Space is very important to the Russians.

Now, we have to have a prudent approach. We have to safeguard American technology. And we have to be sure we have a backup, because we do not want to risk the whole Space Station. So, we have to find a number of off-ramps in case a problem should occur, and we have a backup plan.

So, we have a plan that makes sense, but it is in the U.S. national policy to interact with the Russians appropriately.

Now, during the height of the cold war, I might point out, that President Nixon felt it was in the national interest to engage the Russians in a positive manner with the Apollo-Soyuz mission. We were able to carry that mission out at a time of maximum stress between our countries, and deliver what was important to people in both countries.

If we apply the same rules, and have prudence to how we approach it, we have to earn the Russians' trust and they have to earn ours. And we have a period of engagement so we could monitor that. But the benefits to us are enormous. Instead of having a Space Station roughly on the order of 400,000 pounds on orbit, we will have an 800,000-pound station with much more power, much more volume, and as the Vest panel points out, we will have dual access, which is crucial to the safety.

Senator HUTCHISON. Well, I agree with the concept. Can they deliver? I mean they have delivered on time this year. Do you think that that stability will continue? Do you see that in the long term?

Mr. GOLDIN. I do not have a crystal ball. And that is why I said we have to have a program with prudence. My sense is they will deliver, because space is very important to the Russian people. And when we talk to them about a broad range of subjects, they made it very clear to us, space was No. 1 on their agenda.

They are giving up their national program, the Mir 2, to join the international space station, because they think it is very important to join with the other nations of the world in performing this activity. Now, we have designed the Space Station so it allows the Russians to join in. If they do not, which I do not believe will happen, but it is a probability—you know, I cannot sit here and say I guarantee it—we can proceed forward.

It will not be as good a Space Station. It will cost us more. And it will take longer to get assembled. And it will not have the same value. But America is going to launch a Space Station. We are going to stop debating it. We are going to stop having a bunch of paper reviews and people talking, and we are going to put hardware into space.

I hope and pray we do it with the Russians to make our world a more peaceful place—to engage them in a very positive activity, so their people are building things that lead to the positive aspects for society instead of having them build weapons.

Senator HUTCHISON. Do you have any estimate on what delay it would cause us or what cost it would be to us if they did fail to deliver on their part of our agreement?

Mr. GOLDIN. We are in the middle of looking at these off-ramps. But let me say that it probably would cost billions of dollars and cost us on the order of a year or two.

Senator HUTCHISON. All right. Let me just change to one other area, and that is your commitment to dual-use technology transfers and moving NASA toward more cooperative involvement with industry in the commercial arena. How do you see that working, and how do you see that helping in the costsavings and also contributing to the industry product? How is that being handled?

Mr. GOLDIN. American industry has a tremendous knowledge base. They have a tremendous learning. And if we could just take a look at Boeing as an example. It used to take them I think it was 8 years cycle time to start with a new aircraft and then bring it to market. If I am correct in my data, I think the 777 is being brought to market in under 5 years, and they have a goal of reducing that even more for the next plane. This is through the utilization of advanced commercial business techniques.

In the space area, there are a lot of successful companies in the United States that are building spacecraft in 2 years—very complex spacecraft. General Electric, and now the Martin Co., undertook a contract to develop three new spacecraft for AT&T for the cost that it takes NASA to build one. Why should we not be listening to the industry?

So, we have set up a new experimental program. The request for proposals just went out. And we are running a test. Can NASA do it properly?

And on this program we had a conference with the industry. We said, "What are your ideas? You tell us how we should shape this RFP, because we want to go from design to launch in under 3 years. We want to reduce the weight of all the extraneous subsystems on the spacecraft so the payload mass fraction goes up by as much as a factor of 2. You tell us how to go do this."

We just sent out the request for proposals. And instead of taking a year from the time we submit the request for proposals until we select a winner, we are going to do it in 90 days. There will be no more than two to four NASA people managing this program. And what we said to the contractors is, use NASA as a subcontractor. If you need technology transfer, you direct us and tell us how you want us to give you technology.

This is one of the experiments we are undertaking. We are very, very excited about the possibility. We are looking at a variety of other programs to do it this way, too.

And we are also saying to them, you tell us in your proposals how the technologies that are developed under this contract is going to contribute to the American economy. And we would like you to work with a variety of small companies, because small companies provide innovation in America.

And there are some companies where the small company is the prime and the major contractor is the subcontractor, because they are recognizing that we need this agility. This is but one example of the new approach we have.

Another approach is the international space station. We had 2,400 NASA people, plus on the order of 1,000 to 1,500 support contractors managing the contract. I am happy to report today that we got the total number of people on the program—it will be I think—we promised 300 and we are projecting 318 people on the NASA management team. That is a long step forward.

We have consolidated down to one center, one program manager. There is one human being in charge of the Space Station, not five as we had before, Will Trafton. He is fully responsible and accountable. This is a different way of doing business. And in the process, we are asking the industry to tell us how the dual comes.

And the other example I give you is the aeronautics. The possibilities are incredible. Will we get a $250 billion advanced supersonic transport? I do not know. But we have a higher probability if we go forward with this High-Speed Civil Transport Program. That is what we are doing.

Senator HUTCHISON. I just want to end by saying that I do have a dream that the National Aerospace Plane will be a reality some day. Because that is where we can put all we have really learned into space into something that will be viable, I hope. But I realize that that is not in the cards in the very near future.

Mr. GOLDIN. Well, let me tell you. You are on the right track. What is in the cards is I believe in the next 5 years we will prove we can get positive thrust out of a scramjet engine. And we will figure out where the boundary layer separates. This is where the flow goes from nice and smooth to very turbulent. So, we will determine the heating effects.

If we have those two pieces of data, in 3 to 5 years we may be ready to build an experimental plane that could be flown by a pilot.

But, again, I come back to the point, you do not solve a problem by throwing money at it. And some people are measuring success of the NASP program by how many dollars we are spending. When you say, how many dollars are we spending, you are talking about a jobs program. When you say, what are your technical achievements you are going to make over the next 3 to 5 years, we are putting our money where our mouth is.

We are not guaranteeing to spend money, but we are saying we are going to do whatever it takes to get a scramjet operating in space.

Senator HUTCHISON. Well, I hope I am still here to try to help make that happen.

Thank you.

Thank you, Mr. Chairman.

Senator ROCKEFELLER. Thank you, Senator Hutchison.

Senator Lott.

Senator LOTT. Thank you, Mr. Chairman.

And, Mr. Administrator, welcome. It is good to see you again.

Dr. Cordova, welcome.

And, Mr. Peterson, we appreciate your being here.

I am sorry I did not get to hear your testimony, but I believe we have your prepared remarks, and we will go over that.

Let me just ask you a couple of questions. With regard to the President's 1995 budget request and the 5-year plan, according to the chart that you have here and your papers, it comes down from 1994 just under 15 on a continuous slide down to—what would that be?—just above 12 in fiscal year 1999; is that correct?

Mr. GOLDIN. That is in constant 1994 fiscal year dollars.

Senator LOTT. So, at the end of the decade, then, and the end of the century, instead of being $92 billion as was anticipated, it would be $66 billion over the multiyear period. So, it is about 18 percent less than what had been anticipated in the 5-year plan; is that correct?

Mr. GOLDIN. It has come down; yes, sir.

Senator ROCKEFELLER. Senator, if I can just clarify. That equals the $80.4 billion for the 5 years in unadjusted dollars?

Mr. GOLDIN. In unadjusted dollars it is $72.4 billion over the 5-year period and, corrected for inflation, it is $62 billion for the fiscal year 1995 plan.

Senator LOTT. In order to achieve that, and I think you have been doing a commendable job with a shrinking budget—and you know it is not just this administration. Over 3 years the budget has been shrinking each year, and that is because we are under budget pressures, too, but you have been trying to do a very important job and a difficult job, because it has been a difficult time for NASA over the past 3 years with less money, and now also, of course, you are going to have fewer people, and it shows your employment would drop from 24,731 to approximately 21,100 at—again, at the end of the decade, and we all need to try to find ways to do better work with less money with fewer people, but it is not easy to do.

You say you have a plan to accomplish this reduced number. Briefly, what is your plan? I mean, are you going to try to spread it out throughout the agency? Are you going to have a greater re-

duction in certain areas over others? What is your plan to accomplish that?

Mr. GOLDIN. We have had a series of meetings with the associate administrators and center directors to see what tasks were appropriate for NASA to do and what tasks are not appropriate, so in addition to saying we will get more efficiency, we have eliminated tasks.

There has been a growth in the NASA budget over the last decade to put a little bit more emphasis on administration and lesser of an emphasis on technology, more of an emphasis on having contractors working for us and managing them. Rather than having contractors work for us, clearly establish what has to be done, give the appropriate oversight.

But the big problem that we have relative to this plan is, we came up with this plan early last year. We said to do it in a sane, humane fashion, it is essential that we have a buyout. We have to treat our people with dignity. We do not have to abuse them, to push them out the door. Now we have money appropriated. The House and the Senate have approved our buyout, and unfortunately the Congress went out of session just when the bill was coming back to the House for final approval.

We believe if we get a buyout we will get the folks retiring. In fact, as soon as the buyout was announced, our attrition went almost to zero. There are a lot of people who have worked real hard that we believe are ready to leave. Now, we do not know which centers they are going to come from.

Senator LOTT. So, you are going to try to accomplish this from shifting some of the numbers, from what had been a growing number in administration and more into technology, and a lot of it by attrition and the buyout?

Mr. GOLDIN. Yes.

Senator LOTT. In that connection, you and I are both very familiar with the votes last year on the advanced solid rocket motor engine. Fortunately, the Senate did support it. We could not get it through the House, and so it is now in a closed-down mode, but one of the problems we have is there have been, or there are, people that were associated with that that had relocated, like from California, and been dislocated, and as you know, we have a problem in trying to address the needs there, and I am continuing to work on that, and I hope that you will assist me in that effort.

Mr. GOLDIN. Well, let me say this: when the superconducting supercollider was canceled, there was a very clear thought about how human beings would be treated, and there was—part of that bill was a coverage of people for relocation expenses, and as I understand it, I think your office is in the process of getting a bill together to cover those costs, and we will be there for that bill if it goes through.

Senator LOTT. Great. With regard to your funding and your reduced numbers, do you recall when we started the Mission to Planet Earth Program?

Mr. GOLDIN. It may have been about 4 or 5 years ago.

Senator LOTT. I remember specifically when it started, I think probably only about 4 years ago, but as you know, every year it has been dramatically increasing. It is a program that I had some

doubts about, or reservations about, and yet in this year's budget the Mission to Planet Earth section gets an increase of 21 percent, but yet aeronautics is slashed by almost an equal amount of $200 million. Are these priorities out of order? How would you comment on that?

Mr. GOLDIN. Well, first let me address the aeronautics issue. If you take the aeronautics budget, we had a significant wedge in the budget. It was associated with building of new wind tunnels, and the upgrading of wind tunnels.

The administration is in the process of exploring the possibility of two major new wind tunnels that the industry has asked us to look at. The industry said this is something that is well beyond their ability to finance by themselves, so in the budget, because we do not understand where we are going with wind tunnels, there is an opening, with the decision process to be made sometime later this year, as to how we deal with wind tunnels, and in fact the administration has asked the industry to explore creative financing approaches that will not come back to NASA fully funded, but to see if there are possibilities to fund the facilities through the usage by the contractors and not have to get the Government to fund it.

Senator LOTT. So, what are you saying, that there may be a need for additional money perhaps by innovative ways, but for additional funds in the aeronautics area?

Mr. GOLDIN. But what I am saying is we hope, if it is possible, if the need is really there, to look at it that way, but if you take a look at the core program in aeronautics, that core program over the 5-year period is growing.

Senator LOTT. What I would like to get at also is, I believe last year that the budget request had a 19-percent increase over the previous year for Mission to Planet Earth, and now it is up another 21 percent at a time when your overall budget is falling and the numbers are being reduced in very critical areas like aeronautics, and so, how is this happening? Do you support a 21-percent increase for Mission to Planet Earth?

Dr. CORDOVA. We have, Senator Lott, a well-formed program that, as you know, we started a number of years ago.

Senator LOTT. You say you have one?

Dr. CORDOVA. We have one in place for building spacecrafts in order to achieve our milestones of when we want the various spacecraft in this program to be launched and to bring in continuous data on various aspects of the global change problem, and this year we are ramping up in order to start on the spacecraft effort.

Senator LOTT. Are you going to ramp down in the future?

Mr. GOLDIN. It goes flat, just about, with inflation in the future.

Dr. CORDOVA. Right, after these first few years, but we do have a number of spacecraft in the program, and we started out with a much, much larger kind of program. As you probably know, we have really scaled it back.

Senator LOTT. What is your total request for funding for this particular program in your budget this year, how many dollars?

Dr. CORDOVA. $1.24 billion this year.

Senator LOTT. $1.24 billion for a program that did not exist 4 years ago. Is that accurate?

Dr. CORDOVA. Yes, sir. Yes, it is.

Mr. GOLDIN. Senator Lott, let me give a broader perspective on the numbers. Two years ago, there was the intention to spend $11 billion within this decade on that program, and in last year's budget we cut that back from $11 to $8 billion, and the runout cost for the program was cut back from $8 to $7.3 billion, because we believe we will be able to do the job in a more efficient manner.

But the rise you see, as Dr. Cordova said, is the fact that we have a number of new spacecraft coming up, and the information system for it. It is an administration priority, and it is an important program, and if we do not fund it up we will not be able to do the research necessary to collect the data that we need.

Senator LOTT. Well, I would say that I think—and many people would identify it as an important program, but I just think when you weigh it against a lot of other programs that are being cut, I have problems with that.

Let me shift to another question, if I could Mr. Administrator, because I do not want to infringe on the chairman's courtesy and patience too long, but if I could just ask a couple of more questions with regard to the Yellow Creek facility which we have a substantial investment in now, hundreds of millions of dollars, and then the Congress backed away from it after first supporting it for several years, an effort has been made to find other activity to go forward there.

You have been helpful in trying to see if there was a way that that could be logically done, and I understand—well, I would just put it to you this way. What is the status and the schedule, as you understand it, for the transfer of the nozzle work to that Yellow Creek facility?

Mr. GOLDIN. First, let me say that we believe it is in the interest of the U.S. taxpayer, given the investment we made in that Yellow Creek facility for ASRM, to build a modern nozzle plant that will be a center of excellence for the NASA nozzles for a human space flight program.

We undertook the study, which we kicked off with Thiokol to cause that transfer to take place. It is a 90-day study. We are on track to get the results of that study I believe it is April 3 or 4, and as soon as we get those results it is looking like we are on track to get the transition going to the schedule that we had talked about before. It looks like there will be significant benefits to the U.S. taxpayer.

Senator LOTT. Do you have sufficient funds to complete the ASRM termination?

Mr. GOLDIN. Yes, and in fact—correct me if I am wrong, Mr. Comptroller, but we believe we will terminate that program with $13 million less than we initially estimated, so we tried to be more efficient in that, too.

Senator LOTT. The one other area is, as you know, we have built a high heat flux facility at the Stennis Space Center, and it has been completed and was dedicated last year, and we have invested—NASA has invested right at $20 million in it. I have always supported NASP before we had the high heat flux facility there at the Stennis Space Center. I still do. Will that high heat flux facility continue to play, and will it play, a key role in this future hypersonic research?

Mr. GOLDIN. I believe so. I am not familiar with that specific facility, but I do know that we will be doing hypersonics testing down at Yellow Creek, or testing materials and other equipment for that. We are looking at two applications where hypersonics is involved. One is for the hypersonic vehicle, which is a vehicle that takes off horizontally and lands horizontally. There are two other vehicles that we are looking at in an advanced technology sense that may offer some leapfrog that will be intermediate.

Until we get that new hypersonic vehicle going—and there is a broad range of testing that will be done in the facility for that also. It is a single stage to orbit technology, and I think that will be even before the hypersonics.

Senator LOTT. I just want to remind you, and I know you know quite well, but we have got a brandnew facility sitting there, built for this specific testing purpose, $20 million, and I think it would be another tragedy if we did not make use of an existing facility. I hope you will keep in mind that facility and look for ways to make use of it, perhaps even private sector use in some way or another, but I just hope that you will continue to think about that, and continue to make use of it.

Mr. GOLDIN. I will have a detailed look at it, and we will give you a formal response, because I think it is a very good question you asked.

Senator LOTT. Thank you, Mr. Chairman.

Senator ROCKEFELLER. Thank you, Senator Lott.

Dan, just a couple of questions, and we will wrap up, and I will have more questions to submit to you. You have listed your priorities, and they are reflected in the 1995 budget request—space shuttle safety first, Space Station second, Mission to Planet Earth third, aeronautics fourth, and space science fifth.

Mr. GOLDIN. I believe I testified to that when I was here in November.

Senator ROCKEFELLER. As I indicated earlier, Norman Augustine, who was former chairman of the Advisory Committee on the Future of U.S. Space Programs, had a very high priority on space science, and to the extent that you care to, could you explain to me where you two might differ?

Mr. GOLDIN. I would be pleased to. First, I think there is a definition of terms we have to undertake. When I think Norm Augustine was talking about "space science," he was all-inclusive of earth science, astrophysics, planetary science, life in microgravity science.

When we say "space science," we only refer to planetary and astrophysics and space physics, so when we combined all of these scientific activities, I think you will see in this budget that traditionally NASA, when you include the infrastructure and launch vehicles that goes along with it, spent about 25 percent of its budget for science, and we now are spending 30 percent.

I think we are meeting the spirit of what Norm Augustine was looking for, and in fact in that package you have with my testimony there is a chart that shows the Human Space Flight Program came down from 47 percent at the beginning of the 5-year period, and it will go down to 38 percent, whereas space science goes up from 25 to 30 percent.

. We have done exactly the type of thing he talked about, but when he talked about space science being prioritized, he was talking about a budget that would increase 10 percent a year over the period, so you could build on top of what you had.

Given where we were, given that the fact that in real buying power that budget is coming down, as Senator Lott pointed out, we still were able to prioritize science in the broadest sense.

Now, we do have one specific issue in astrophysics, and the space science area as NASA defines it, and we believe there are a number of new activities that we have to look at, and we believe we are short by $100 to $300 million. When we submitted the budget to the OMB, we told them that we had this problem not in 1995 but in the out-years, and we plan to work with the scientific community, as I indicated, to see how we might make up this shortfall by rearranging what we have and not by adding more money onto the top, and that is the one place where I think Norm would fault us.

Dr. CORDOVA. But could I please add something, that this is the first time in the Nation's history that we have been able to support three major programs—AXAF, Cassini, and the Hubble space telescope—and I think that is a remarkable accomplishment for space science and for this budget, and one that will attract the students that Senator Hollings was talking about.

Senator ROCKEFELLER. You say that the Space Station, under the nexus of life sciences, will be developed primarily for life and microgravity sciences research?

Mr. GOLDIN. Yes.

Senator ROCKEFELLER. But then, in the fiscal year 1995 budget request, there is a decrease for life and microgravity sciences funding.

Mr. GOLDIN. There is a discontinuity, and then it starts going back up again. A number of things led to that. Each and every year—we cannot be continually coupled to continuing growth. We have to plan the activities in each year.

In fiscal year 1994, there were a number of activities that were in that budget line, preparing us for going to the MIR space station with science. We completed those tasks, and rather than just filling it in with more money, we said, we will be task oriented.

There was some carryover of funds from 1994 to 1995, that also provides finances for doing the test. So, rather than saying we want to have more money and then build upon it, so we will build a peak, we are going to maintain an appropriate program.

But overall, it is the right program. It is a program that has been reviewed by the scientific community and by the NASA people; and Harry Holloway has convinced me, this is the right level.

Senator ROCKEFELLER. That is an acceptable answer. In other words, you are just placing it in the 5-year spectrum, where you think the amounts are most appropriate.

Mr. GOLDIN. And I might say that, when we first began, we had canceled a number of spacelab missions. We had even less money. The National Academy of Sciences, National Research Council, came back and said, "We think you've made a mistake."

So, we put back into the budget a couple of things that we had taken out, because the scientific community said we cut too far.

One of them was Neurolab, which is a joint laboratory that NASA and the National Institutes of Health are going to be doing in space, to look at brain research.

Senator ROCKEFELLER. Tell me about that.

Mr. GOLDIN. It is a laboratory that is going up in 1997.

Dr. CORDOVA. It is called SLS–4.

Mr. GOLDIN. Why does Harry not come up, because Harry is the physician; and rather than having an engineer-physicist tell you, I think it would be good to have the person that is the national expert tell you.

Mr. HOLLOWAY. Mr. Chairman, I am Harry Holloway. I am the Associate Administrator for Life and Microgravity Science.

The Neurolab is a joint NASA/NIH program, which will focus on the neural sciences, utilizing the facilities of the spacelab. Particularly, it will focus on research that has to do with the total of our balance mechanisms: Those things that sometimes get disturbed in elderly individuals; and they are a major area of research of the NIH, for areas that have to do with posture and things that specifically interact with gravity, and the examination of plasticity of the nervous system and the way the nervous system changes when it moves into microgravity environment, and out of that.

And so, it is a relatively complex mission. It has been, already, gone out on its announcement of opportunity; and the joint efforts in this case between NIH and NASA are coming to peer review just at the present time, for this particular flight. And there are in excess, I believe, of 148 applications that have made it through to this stage, that will eventually be reviewed.

This is going to be a very rich mission in providing fundamental science about how gravity operates to program and shape the way our nervous system regulates our bodies and our, even, stress responsers—which many people do not realize—but the things that control stress in our lives. The norepinephrine and epinephrine secretions of our adrenal gland are things that operate in our body, to maintain blood pressure against gravity. So, these are all gravity hormones.

So, those are all being investigated in this single mission.

Senator ROCKEFELLER. That is interesting, because that brings up the question, in fact. There has a lot of attention paid to what kind of, what science should be done in space: What part of it should be the curing of diseases, the research into the cause of diseases? And there is a lot of kind of dispersed and abstract hope—and some of it, very specific hope—that relates to health breakthroughs and health knowledge.

How do you make decisions, as to what you are going to do?

Mr. HOLLOWAY. There are several different ways. One of the important ways is by staying in very close contact with the overall scientific community; to be aware of the critical scientific questions within that scientific community; and ensuring that that community, both advisory, from an advisory point of view and from the point of view of peer review, is actively involved.

In addition, of course, we also have priorities that grow out of NASA programs: The health of our astronauts themselves, and the maintenance of that health; and the provision of safety. These also give us other priorities, but inevitably the program must come for-

ward and withstand rigorous peer review from the outside community, so that clearly we are using this very valuable resource in a way that will contribute to that community; and so that community can made comment on that.

In addition to that, of course, we then meet all of the priorities that must be brought within the envelopes of budgets and other constraints that operate within a large organization.

Senator ROCKEFELLER. Why do you not pursue that with me; and then, talk about what are the priorities now, with respect to health research and related areas; and what are priorities, but they fall just short of being able to be funded at this time, but you would like still to be able to do that, but cannot?

Mr. HOLLOWAY. The research that is, of course, most important to us is research that will have a major health effect. And then, of course, within that subcategory of health effect is one which will have a health effect on our astronauts; and that involves gravity as a critical variable, or involves some other aspect of the space environment, such as, extreme vacuum exposure to radiation, as an important issue.

We are also interested in anything that will allow us to fundamentally understand how life adapts to gravity. It turns out that a large portion of life sciences research that is of interest to space as an area that sometimes go unmentioned, is plant research. Understanding the productivity of plants requires an understanding of gravity receptors in plants, because plants are very, very receptive to gravity.

The areas of research that we are able to fund at the present time generally, and this reflects very much the same sort of thing you will hear from NIH, we reflect of our research proposals, we are able to fund about 25 percent of those research proposals.

The kinds of research that we would like to see develop is dual-use research. And, if could characterize that for you very briefly, so that perhaps I can dramatize it, in a sense.

If we take a look at capacity to step off a curb, that is the reflex that operates from your inner ear to your foot. The soundness of your bones, OK, that is the second item; and fractures of hips. You discover that those things are intimately related.

Elderly individuals—and this costs us billions of dollars a year in our health care industry—fracture their hip when they step off the curb, they fracture their hip before they fall, and then they fall. And that is secondary to osteoporosis.

These three themes, when you organize them together, involved the nervous system which controls that step; the muscle system which controls the machine that moves it; and the overall bones, and the fundamental metabolism of the bones. And all three of these are extremely gravity-sensitive systems.

When we can identify this kind of target, this is a target that is most critical to our astronauts and to a large portion of our health care. So, then, we work with NIH, that means the Arthritis Institute, the Institute for the Aging, the folks who are in the Hearing Institute. Those are the people who, then, are very active and very much want to collaborate with us; although now, because of their other biological issues, so does NCI and several of the other institutes.

In addition to that, we discover that migration of cells in space are critically affected. That has to do with the overall problem of metastases; and therefore, we do have the collaborative research with the NCI.

Senator ROCKEFELLER. Explain that for me.

Mr. HOLLOWAY. A metastasis is when a cell from a—a group of cells in your body have gone, become undisciplined, and they become a cancer. And some of those cells go to other areas of your body, where they also grow in an undisciplined way.

And, of course, the undisciplined behavior of this cancer eventually kills you. That is the overall problem of cancer.

It turns out that cell migration is, in ways that we really do not fully understand yet, affected by gravity. The cell itself, the little tiny cell.

And so, understanding this phenomena—which was first, by the way, observed in lymphocytes and is now being studied fairly heavily—and lymphocytes are white blood cells. They are the little things that fight off infection. Dan always wants to keep me straight on these things so that I get it down, so that it is clear.

And the small, those little cells were noticed not to migrate in space the same way they do elsewhere. That has given us a critical understanding of what causes cells to migrate.

Now we are beginning to look at how cancers grow, and what things cause them to migrate; and that is a critical question of metastases, that funny word I used about those cells going off and becoming undisciplined. The folks at M.D. Anderson, at the Cancer Institute down there, are researching this and using the opportunities afforded in space.

Now the areas that we have, or that we have many good pieces, many good researchers who we simply cannot fund—we have been able to work with NIH in a program that had a good deal of sponsorship; and in fact, in both the House and the Senate they asked us to do those programs jointly, and that has proved to be very profitable. That has allowed us to increase the quality of research and the quality of our applications.

But there are many applications that are not able to make it, and that is the usual 25 percent that get funded. And that gives you a very good 25 percent, but there are many good projects that go unfunded.

The areas that we also work in, and I think you and I have interacted on this on occasion, are areas like telemedicine, and how to bring that technology back and apply it on Earth. And in those areas, developing those kinds of Earth applications, we—I would not want to characterize this.

That is an area where we could expand our efforts very easily, to have more contributions back to Earth, of that particular kind of activity.

But we do have, and we have created now a very vigorous and very active program in order to accomplish that, that kind of study where we are using the telecommunications development at NASA and our capacity to create the sorts of technologic innovations that Mr. Goldin was talking about: To visualize, for instance, the back of your eye; to diagnose blood vessel disease secondary to diabetes,

and to transfer that to a doctor at a distance. To help a less experienced doctor get consultation from a very experienced doctor.

All of those issues in telemedicine, and the development of the appropriate protocol so that that can be used, is another very active area of research, and dual-use technology. Those are all areas where it would certainly be reasonable to have some expansion in some of those areas; but you can buy only so much.

Senator ROCKEFELLER. I understand. Doctor, that is very helpful to me. And I want to know, Senator Lott, if you have any more questions? And Dan, do you have any closing comment? That lasts no more than 60 seconds? [Laughter.]

Mr. GOLDIN. Yes, I will take 60 seconds.

First, Senator Lott, we have researched this facility you asked about, and there are a number of applications that we intend to use it for; and we will make that available to your office.

I would like to close by saying we did not ask for a tough budget, but we are going to continue to do bold, difficult things. America is a turning point. We have to decide the criticality of space to our future.

Recognizing this downsizing, we are looking for excellence in everything we do. Dr. Cordova is going to be heading up the NASA Science Council, to assure that as we are downsizing, quality goes up.

Scientific standards remain very, very high; and we are picking the very best in America. and not just looking to protect jobs. And you will be hearing about this, in the near future.

Senator ROCKEFELLER. Dan, I think you are doing a very good job on this. I think you do take it seriously. Your intensity is constant, and it is credible; and I think you are showing in your performance that you are able to make cuts and sustain programs better than a lot folks who work in Government.

So, I am impressed, and I believe generally that you can feel that this committee is impressed. I know that Senator Hollings was, because he expressed it to me just before he left.

And so, your own personal crusade on this, to do as much or more with less, counts with this committee; and it makes it easier for us to try to help you. And so I thank you.

This hearing is adjourned.

[Whereupon, at 4:25 p.m., the hearing was adjourned.]

APPENDIX

Questions Asked by Senator Rockefeller and Answers Thereto by Mr. Goldin

OVERALL FY 1995 BUDGET

Question. NASA's budget request for FY 1995 is $250 million lower than its FY 1994 appropriation. What were your assumptions in taking institutional reductions rather than canceling programs to achieve reductions? What are examples of "institutional reductions" and how do they impact NASA programs?

Answer. During formulation of the FY 1994 budget request, NASA undertook a far-reaching examination of its major flight programs and reduced the five-year budget projection by 18 percent. Major reductions were taken in the costs of the Earth Observing System, the Advanced X-Ray Astrophysics Facility (AXAF), and Cassini. Initiation of the Advanced Tracking and Data Relay Satellite System had been deferred, and a major redesign of the Space Station was underway. Congressional action on the FY 1994 budget request reduced the NASA budget runout further, by canceling the Advanced Solid Rocket Motor Program, the Search for Extraterrestrial Intelligence, the Shuttle structural spares program and the AXAF-S spacecraft. Operations costs for the Space Shuttle system were substantially reduced through consolidation of contracts and implementation of system efficiencies, and reductions were taken in funding for support contractors.

This aggressive approach to the FY 1994 budget made formulating the FY 1995 budget a greater challenge. In order to maintain the agency's key initiatives in aeronautics and space while being responsive to the President's determination to confront the economic challenges of limited federal resources, NASA focused on reducing our administrative costs even further. Examples of these reductions include: not allowing adjustments to keep up with inflation in some programs; reductions in funding for computer acquisitions and services; reduced funding for support contractor services; reductions in planned civil service levels; and closing facilities of marginal value. These reductions should have no direct impact on NASA's programs.

Question. One of your highlights in your testimony is the "program balance" you have been able to achieve in the FY 1995 budget request. Please explain how aeronautics funding, which will be funded at $898 million (or 6.3 percent) out of the total NASA budget, is "balanced" with funding for the space program.

Answer. The FY 1995 budget request for aeronautics has been built in close cooperation with industry to ensure that the programs produce useful technology. The main focused technology programs, the High Speed Research program and the Advanced Subsonic Technology program are at full momentum. NASA is working closely with the Department of Defense, the Administration and industry to formulate a strategy for new wind tunnel capabilities. The Hypersonics program has been restructured to develop the most critical and long-lead technology for hypersonics-propulsion. The primary objective of the new hypersonic technology effort is to develop and demonstrate a scramjet at speeds up to Mach 15 through a series of ground-based and flight experiments. The Research and Technology base activities are structured to address high priority long term research areas, such as materials and structures, aerodynamics, and propulsion and power, that are crucial to the aeronautics industry.

The NASA budget request for FY 1995 balances the need for fiscal restraint with the need to maintain the agency's key aeronautics and space initiatives. This budget request is responsive to the fiscal reality of limited federal resources, yet provides funding to sustain the momentum that has been achieved in the Aeronautics program over the past several years. This budget request continues the strong commitment of the agency to a leadership Aeronautics program.

FY 1996 AND BEYOND

Question. NASA's budget is projected to remain around $14.3 billion for the next several years. Given fixed costs for space station and space shuttle and planned increases in Mission to Planet Earth, what will be the impacts to the space science and aeronautics programs?

Answer. The NASA FY 1995 budget request of $14.3 billion maintains all of the agency's key initiatives in aeronautics and space. It provides for a safe and viable Space Shuttle flight program; the continued development of the Cassini mission to Saturn, the Earth Observing System, and the Advanced X-Ray Astrophysics Facility (AXAF-I); the International Space Station; the continued utilization of the Hubble Space Telescope; and two key initiatives in Aeronautics, the High Speed Research and the Advanced Subsonic Research programs. Funding to continue development activities on the first two Discovery missions, the Mars Environment Surveyor(MESUR)/Pathfinder and the Near Earth Asteroid Rendezvous (NEAR) mission is included, as is funding to initiate a new mission to capture data planned from the Mars Observer mission. NASA has been extremely aggressive in identifying areas to cut in order to accommodate this balanced program within a budget that allows for little total growth. The Space Shuttle program has reduced its funding projections through implementation of contract consolidations and streamlining operations to reduce manpower requirements. The Space Shuttle program will continue to seek efficiency improvements, although not at any risk of compromising safety. In many program areas, we have not allowed for adjustments to keep up with inflation. We have reduced funding to maintain institutional support, such as computer acquisitions and services and support service manpower. We plan to close facilities that are of marginal value to our programs.

NASA still faces the challenge of incorporating new science missions into the long range budget plan. We are looking at how to fund new science activities. The agency will continue to push for greater savings and to encourage all programs to find cheaper ways of accomplishing their objectives.

Question. The $2.1 billion Space Station annual cap was set before Russia was limited to participate in the program. Does the $2.1 billion cap provide sufficient funding for the program with Russia? Does participation with Russia increase the total cost of the program as redesigned last spring?

Answer. The $2.1 billion cap provides sufficient funding for the international Space Station. Cooperation with Russia decreases Program costs, adds capability, and accelerates the assembly schedule.

Question. Last week, Canada announced it would reduce its costs in the Space Station Program. What is the impact of reduced Canadian participation in the international Space Station? Will reduced costs to Canada result in increased costs to the United States?

Answer. Canada has long been an important partner in the international Space Station, and NASA is confident that Canada will continue to play a vital role in the program. However, the Canadian government is under significant budget pressures and must re-examine all expenditures. Just as redesign of the Space Station last year yielded a highly capable program for significantly less cost, the review by the Canadians holds the potential for reshaping a successful partnership.

Currently, Canada plays the predominant role in providing the robotic systems necessary for Space Station assembly, maintenance, and external operations. NASA and the Canadian Space Agency have established a working group to examine options for reducing the cost of the Canadian contribution with as little impact as possible to NASA and the other international partners. The results of this activity will be available by mid-April, 1994.

Question. What are the options for the Space Station Program without Russian participation? What are the estimated costs and schedules of these options?

Answer. The Space Station Program is performing contingency planning, including several detailed approaches, to allow the United States and its partners to complete the Space Station should Russia decide not to participate. Administrator Goldin will soon present these plans to Congress.

SPACE SHUTTLE

Question. Since 1992, reductions totalling 24 percent have been taken in the Space Shuttle Program alone. What are the impacts on safety and capability of the Space Shuttle as a result of these reductions? Can you assure us that these reductions will not compromise safety of the Space Shuttle?

Answer. The Space Shuttle continues to be operated safely and efficiently with the reductions that we have experienced in the last several years. We have increased our efficiency and therefore reduced our cost by increasing personnel train-

ing, benefiting from investments in operations hardware, restructuring program elements for the long term and have changed the business practices with contractors to include cost reduction incentives. We have not jeopardized safety by cutting costs. We have continued to stress safety in all areas and are presently supporting several independent teams, General Research Corporation (GRC), General Accounting Office (GAO), and National Academy of Public Administration (NAPA) that are reviewing our cost reductions and subsequent safety implications.

Question. One of the cost cutting measures in the Space Shuttle Program was cancellation of the Long Duration Orbiter (LDO) Program. Please explain what the impact of this cancellation is to the Human Space Flight Program?

Answer. The impact to the Human Space Flight Program due to the cancellation of the Long Duration Orbiter (LDO) Program is minimal. The redesigned Space Station has given the Human Space Flight Program earlier access to a more permanent on-orbit laboratory in approximately the same time frame that we were planning on LDO capability, and therefore eliminated the science requirement for the LDO.

SPACE SCIENCE

Question. The FY 1995 budget requests continued funding for development of the Cassini planetary probe to Saturn and the Advanced X-ray Astrophysics Facility (AXAF). Are these space science programs at risk if NASA is not funded at its request of $14.3 billion?

Answer. NASA's FY 1995 budget request of $14.3 billion contains full funding for the Cassini and AXAF missions, with plans for launches in 1997 and 1998, respectively.

NASA's Administrator, Daniel S. Goldin, has stated that all flexibility has been removed in reaching the $14.3 billion level and that any further cuts would result in substantial harm to NASA's overall program. In this regard, all of NASA's programs are potentially at risk if our budget request is reduced below the $14.3 billion level. How NASA would specifically respond to an actual reduction in our budget request will depend on a number of factors, including the severity of the cut, any Congressional direction that accompanied the cut, and subsequent consultations with the Office of Science and Technology Policy (05Th) and the Office of Management and Budget (OMB).

Question. After Cassini and AXAF are completed, it appears that NASA has no major space science programs to initiate. What is the impact on the quality and capability of space science research if all subsequent missions are required to be small and cheap?

Answer. The Office of Space Science supported by NASA's Space Science Advisory Committee is in the process of evaluating how best to structure a comprehensive space science program that must operate in a fiat budget environment. We expect that they will complete their evaluation and submit their recommendations to NASA in the late Summer or early Fall. It is premature to conclude, therefore, that there will be no najor space science missions following AXAF and Cassini. We will be working with the science community during the next few months to put together a comprehensive space science program that meets the management challenges laid before us by the Administration.

MISSION TO PLANET EARTH

Question. The FY 1995 request of the mission to planet earth program will increase by almost 21 percent. Given the flat budget projected for the next several years, what options are being explored to keep mission to planet earth program costs down?

Answer. The increase in funding from FY 1994 to FY 1995 requested by the President for Mission to Planet Earth (MTPE) demonstrates the commitment of the Administration to this important program. MTPE is dedicated to understanding the Earth as an integrated system and providing information to policymakers and the public needed to support the complex environmental decisions that lie ahead. The majority of the increase is for the Earth Observing System (EOS), which is now moving into full scale development; FY 1995 is a critical funding year for EOS. We project that only modest increases in the next several years—and steady funding thereafter—will be needed to enable the MTPE program to achieve its goals.

NASA intends to meet all its budget commitments, and Mission to Planet Earth is no exception. In the last 30 months, we restructured the EOS program to focus primarily on the highest priority global change issue: climate change. In doing so, we were able to reduce the funding required for EOS through FY 2000 from a projected $17 billion to the current estimate of $7.3 billion. In addition, we continue to pursue innovative means of obtaining the needed measurements, taking advan-

tage of new technology, international opportunities, and other improvements in the way we do business. We are committed to sound and careful program management for all Mission to Planet Earth projects, including regular reviews, cost caps, and descope plans. We are working closely with our contractors and researchers to see that the dollars invested in these programs produce the needed results as soon as possible.

Question. Landsat 7, a joint DOD/NASA land remote sensing program is in the process of being transferred to NASA. Since the FY 1995 budget request was submitted before the decision to transfer the Landsat 7 program was made, how is NASA planning to fund additional program costs?

Answer. In addition to its FY 1995 funding request, NASA plans to receive up to $90 million in FY 1994 funds to be transferred from the DoD, in accordance with a jointly signed NASA/DoD Landsat 7 Transition Plan and authorized by Public Law 103-211. NASA also plans to share the development cost of the ground system with NOAA and for to perform Landsat 7 spacecraft and ground system operations; this arrangement will be captured in a revised Landsat Program Management plan jointly signed by the participating agencies.

Internally, NASA has taken steps to restructure and reduce program and project management costs incurred by both the contractor and the agency. As required by P.L. 103-211, the NASA Administrator will soon certify a plan to fully fund the Landsat 7 program and will submit this plan to the appropriate Congressional committees, including the Senate Committee on Commerce, Science and Transportation.

LIFE SCIENCES

Question. In the NASA Authorization bill for FY 1994, NASA was asked to develop an Orbital Research Plan for life and microgravity sciences research on the space shuttle payloads, the Russian space station MIR, and the International space station. What is the status of this Orbital Research Plan? When will the Committee have an opportunity to review this plan?

Answer. The Office of Life and Microgravity Sciences and Applications is fully committed to an orbital research plan that both sets science priorities and directs the most efficient use of both ground based and orbital assets. We have completed a draft version of the plan that we will be circulating for review in the coming months. Because of the fast pace of changes in flight manifests in recent months, we anticipate that the plan will have to be updated before it can be released. We anticipate that this process should be completed by July, 1994.

Once the plan is finalized, science priorities will continue to be refined through the selection of specific research in the peer review process and in consultation with the scientific community through the Office of Life and Microgravity Sciences and Applications' Advisory and Working Groups.

The transition to the Space Station era will be achieved smoothly through the completion of Spacelab flights and the increased use of Mir facilities and, finally, the use of the Space Station. In the future, proposed science will be designed to be "platform independent" to the maximum extent possible. We will employ a rigorous peer review process to select the most valuable science, and direct selected science to the most suitable platform.

AERONAUTICS

Question. The FY 1995 request for aeronautics reduces funding overall from $1,102 million to $898 million, or about 18.5 percent, and specifically reduces the aeronautics research funding. Please explain the impact of this reduction on NASA's aeronautics research and technology base.

Answer. The FY 1995 budget request reflects the new budget structure. As a result of this new structure, the $212 million included in the Construction of Facilities appropriation in FY 1994 is now included in the Aeronautics budget. Additionally, in FY 1994 funding for the Small Business Innovative Research/Small Business Technology Transfer program was included in the individual program are& Beginning in FY 1995, the agency has identified funds for this activity separately, and they are included in the Office of Advanced Concepts and Technology budget request. The FY 1995 portion of ti4is program is $20.1 million. With these changes taken into account, funding for Aeronautics Research and Technology activities between FY 1994 and FY 1995 remains virtually unchanged.

As part of the FY 1995 budget development exercise, NASA conducted a major institutional rightsizing effort to streamline its internal operations. Significant savings were identified in the R&T Base in areas with the least, or no, impact on priority programs, including:

Aircraft Reductions. Streamlined operations and focus on highest-priority efforts will enable the deactivation of 10 research and support aircraft, and reduced usage of an eleventh aircraft.

Facility Closures and Efficiencies. The aeronautics program will close four facilities, place an additional six facilities on stand-by status, and reduce operations in eight other facilities. These facilities include wind tunnels, simulators, and engine test cells. All required and prudent maintenance and environmental investments will be continued.

Operation of Installation Efficiencies. Internal operations at NASA's four aeronautics centers have been "right-sized" through consolidation of automated data processing and other computational efforts; streamlining of scientific and technical information processing and general shop and support services; and reductions in maintenance, printing, reproduction, transportation, and other installation services.

The savings in the Research and Technology Base were used to enable the increases in the focused aeronautics programs (e.g., AST, HSR, and HPCC) that will provide additional returns to the country from the standpoint of technology development, job creation, and sustained competitive advantage.

Question. The request for aeronautics reduces funding needs by closing facilities. Please describe which facilities are on this list and explain how much NASA saves by closing these aeronautics facilities.

Answer. Last fall NASA initiated an institutional infrastructure adjustment exercise to reduce the cost of institutional operations. This effort was part of the overall aeronautics strategy to streamline operations and focus on the highest priority aeronautics efforts. The result was closure of four facilities, placement of six facilities on standby status, and reduced operations in six others. The four facilities identified for closure are the 8-Foot Transonic Tunnel and the 30 x 60 foot Wind Tunnel at the Langley Research Center, and the Powered Lift Facility and two cells of the Engine Research Building at the Lewis Research Center. (Closure of the 30 x 60 tunnel will be conditional on the ability of the 14 x 22 Foot Tunnel at Langley to conduct free flight demonstrations.) These actions will result in a savings of $3.4 million in FY 1995.

Question. World class wind tunnel facilities are necessary for U.S. airframe manufacturers to compete globally. Are world class aeronautics facilities a priority for NASA and if so, please explain your efforts to date.

Answer. World class research facilities, including wind tunnels, are a high priority for NASA and for the domestic aerospace industry. NASA, with the support of Congress, has been very active in the past five years to ensure that adequate facilities are in place to support the long-term competitiveness of U.S. industry.

For example, in FY 1989 NASA initiated a Wind Tunnel Revitalization Program to rescue its aging wind tunnels, investing approximately $350 million over six years. In FY 1993, the Appropriations Committees provided $25 million for facilities related to the High Speed Research Program—primarily acoustic modifications to the 40x80 wind tunnel at the Ames Research Center. In FY 1994, the Clinton Administration requested, and Congress fully funded, $181 million to upgrade aeronautical facilities in support of U.S. industry and government requirements, including $27 million for the Composites Technology Center at NASA Lewis, $60 million for the National Transonic Facility at NASA Langley, $20 million for the Unitary Plan 11-Foot at NASA Ames, and $74 million to support new wind tunnel studies.

Most recently, NASA has been an active participant in a joint government/industry task group chartered to identify and define future high-priority facility requirements. In addition to other findings, the group determined that current U.S. tunnels do not have sufficient Reynolds number capability to simulate the flight conditions of today's complex aircraft, nor the productivity required by industry in today's competitive market. In the absence of this capability, U.S. industry has been using more capable and productive European facilities at a higher cost and at the risk of unwanted technology transfer.

In particular, the need for two new wind tunnels—one in the subsonic flow regime and one in the transonic flow regime—was identified. The task group also looked at upgrades of existing tunnels, but determined that required operational parameters could not be met without new tunnels.

The new tunnels, if built, would support the development primarily of commercial subsonic aircraft. (They would not be required to support the High Speed Research program or a future High Speed Civil Transport, but could be used if available.) NASA, the Administration, and others are currently examining innovative financing, construction, and management approaches to develop a viable set of options that would enable a possible decision to proceed with the tunnels, potentially for consideration in the FY 1996 budget cycle.

TECHNOLOGY INVESTMENT

Question. NASA requested and was appropriated $20 million in FY 1994 to develop a technology program with industry. What has been done to date? What has been the industry response to NASA's efforts to establish a technology program?

Answer. NASA has developed an initial implementation plan for this effort, which has been titled the Aerospace Industry Technology Program (AITP). The AITP is being planned to be a key element of NASA's support for U.S. national technology policy. Strong and active involvement of industry in all aspects of the program will be a hallmark of the AITP, in which a major focus will be the creation of industry-led consortia to implement projects. The program will develop and apply advanced technology rapidly in industry applications, in the non-aerospace commercial marketplace, as well as providing new capabilities for NASA missions. The AITP will support individual projects that will be designed and led by industry, competitively selected by NASA, and managed through funded cooperative agreements in which industry-led teams implement projects. These projects will focus on R&D in pre-competitive technologies and novel applications,supporting high-payoff opportunities that demonstrate strong potential for commercial benefits.

In keeping with the goal of involving industry in the program development process, NASA has briefed and discussed elements of the AITP with industry representatives primarily through aerospace association meetings and forums at several occasions over the recent months. In addition, we have provided information about AITP on both the NASA Internet electronic bulletin board and on the National Technology Transfer Center's 'Business Gold' bulletin board (which is available by modem for non-Internet users) so the aerospace and non-aerospace communities can learn about the program. We have also taken steps to coordinate elements of our program with the NIST ATP and the multi-agency TRP. This coordination provides another avenue of communicating information with industry.

During FY 1994, an initial set of AITP projects will be solicited and selected. This process is underway. The program schedule is: Fall 1993, Preliminary Planning; February 1994, Industry Forum; April 1994, Preliminary AITP Program Information Package; April/May 1994, Release AITP Cooperative Agreement Notice (First Solicitation); Summer 1994, AITP Selection Process; and late-Summer 1994, Initial Projects Announced.

As noted in the schedule, on February 4, 1994, NASA convened an industry forum at Headquarters with broad participation from a cross-section of U.S.industry—large and small, aerospace and non aerospace, traditional government contractors and traditional commercial market companies. At this meeting, some key issues—important to industry and NASA—were discussed in industry-led workshops. For example, the industry strongly urged that a pre-proposal,"white paper" cycle be added to the program to allow more efficient use of industry bid & proposal resources. As a part of the forum activities, we asked the participants to provide feedback on the forum quality and value. The participants response was overwhelmingly positive and expressed the view that the forum was a good opportunity to provide industry input.

We have taken and continue to take the described steps to help ensure that industry participation is included in program formulation, and to broaden the base of participation, while building lasting bridges between aerospace and non-aerospace sectors.

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Question. What are NASA's plans to develop a new space launch vehicle? Is NASA contemplating the use of foreign launch vehicles to launch NASA payloads?

Answer. NASA has recently completed and published its Access-To-Space report, and is a participant in the 05Th and DoD studies to define national space transportation system requirements. These studies address options to reduce per-flight costs and to increase reliability, safety and schedule dependability. The options range from incremental improvements to the existing launch systems to developing a next generation system. The Administration is reviewing the results of all these studies and will address the issue of preparing to meet future launch needs in a planned policy statement on space transportation.

As a general rule, NASA will continue to use domestic vehicles to launch NASA payloads. However, in the spirit of international cooperation, NASA is contemplating the use of foreign launch vehicles in a select number of cases. For example, NASA is studying the potential use of the Russian Proton vehicle to launch the Pluto Fast Flyby mission as part of a U.S./Russia cooperative scientific program.

Further, some U.S. developed payloads, and some joint U.S./Russian developed payloads, are being planned to be launched on Russian vehicles destined for the Russian MIR or NASA's International Space Station. Use of foreign launch vehicles will also be addressed in the Administration's planned policy statement on space transportation.

Prepared Statement of the American Institute of Aeronautics and Astronautics

INTRODUCTION

The American Institute of Aeronautics and Astronautics (AIAA) is a professional organization consisting of 34,000 professional members dedicated to the advancement of the arts, sciences, and technology of aeronautics and astronautics. We welcome this opportunity to comment on the NASA Fiscal Year 1995 budget request.

Our focus this year is on the need to assure a long-term national base of scientific and technological research and development in aerospace. The current Administration, with Congressional support, has appropriately moved to direct national technical resources toward assisting U.S. industry in maintaining leadership—toward holding market share, where appropriate, and toward regaining lost markets and building new ones.

One overriding concern is that this important and appropriate concentration on near-term competitiveness not destroy the already thin long-term pipeline of basic R&D that will be needed in decades to come. To use a cliche, we are worried about eating the seedcorn for the future. Typically, in aerospace, the development time for a new airplane engine is 10 years AFTER basic research has proven scientific feasibility. New revolutionary means to access space also require long lead times, and hold phenomenal potential to reduce the costs of using space while increasing launch reliability.

For many decades, government managers typically have under-invested in technology development because of immediate programmatic needs. AIAA shares its concerns with good company. The 1990 Report of the Advisory Committee on the Future of the U.S. Space Program, chaired by Norman Augustine, stated:

> The technology base of NASA has now been starved for well over a decade and must be rebuilt if a sound underpinning is to be regained for future space missions. [page 2]
>
> Recommendation 8: That NASA, in concert with the Office of Management and Budget and appropriate Congressional committees, establish an augmented and reasonably stable share of NASA'S total budget that is allocated to advanced technology development. A two- to three-fold enhancement of the current modest budget seems not unreasonable [page 31]. [Note: At that time technology R&D represented approximately three percent of the NASA budget.]

In 1988 a panel of the National Research Council (NRC) chaired by H. Guyford Stever, wrote in its report, "Toward a New Era in Space, Realigning Policies to New Realities,"

> Operational pressures and short-term commitments have contributed to [a] turn from more basic research. If the United States is to be in the forefront in space, however, it must soon take action to fill the pipeline with the most advanced technologies * * * Such a program would be characterized by the following critical elements: (1) stability and continuity of funding to carry out long-term research and development in the most effective manner, (2) a strengthened basic research program for generating new options to meeting technology requirements for long-term goals, (3) interagency coordination of program formulation and budgeting stages to enhance synergy and avoid redundant investments and (4) demonstrations of space technology to establish technical feasibility and to facilitate the creation of competitive technical teams in the private sector working in partnership with NASA to translate advanced technologies in to applications.

This report and a 1987 NRC predecessor study, "Space Technology to Meet Future Needs" chaired by Joseph Shea, recommended a three-fold increase in the NASA technology investment.

By failing to invest in the long-term technology pipeline, we are at the very least making future missions more risky and expensive. It is difficult to identify long-term research on enabling technologies that look beyond the next 5 years in today's NASA's programs, but is essential to the long-term economic future of the nation that we do so. As we have noted above, reviews of NASA and its programs by expert outside committees during the past decade have repeatedly resulted in the recommendation to increase support for the long-term technology development pro-

grams to a level of about 6 percent of the NASA budget from the current 2-3 percent range. Almost all efforts in the interim to expand these efforts, both general and discipline-focused, have fallen short after completion of each-year's budget formulation process. In the meantime the amount of aeronautical and space systems technology research sponsored by the Department of Defense (DoD) has fallen, which increases the significance of the remaining NASA efforts.

Our nation's ability to field new aerospace capabilities when needed, to produce more reliable systems, or to reduce the cost of operations is at risk. The domestic aerospace industry's ability to stay fully competitive is also dependent on a continued introduction of capabilities whose development is initiated in NASA or DoD technology programs. Assuring the adequacy and proper balance of the NASA technology development programs should be among the highest priorities in future budget deliberations. The aerospace technology edge that the United States has had over the rest of the world has been one of the nation's great strengths for much of this century. Failure to properly nurture new aerospace technologies makes that national prowess less certain in the future.

For these reasons, the AIAA supports efforts of the Subcommittee to strengthen NASA's technology investment activities. Legislation such as the "National Aeronautics and Space Administration Technology Investment Act of 1994" (S. 1881) can pave the way for improved government/industry partnerships and can enhance our nation's competitive stance. Such measures can help to transform NASA from a Cold War organization to an organization that not only continues to push the frontiers of science and technology, but also meets the demands of the post Cold War world. It is important to stress that NASA can indeed seek commercial applications of the technologies developed for the agency's fundamental missions in space and Earth science, space exploration and development, space applications, and aeronautics without prejudicing the effective pursuit of those missions.

Technology is not the only precious commodity in the current global scene. The loss of jobs over the past several years, and the projected loss of considerably more through the turn of the century, has been of grave concern to the Institute and its other technical friends and colleagues. These individuals are among the most well-educated men and women in our country, and are responsible for making our nation what it is today. The serious erosion of our technical ability will inhibit our capability to compete in a very short time. The loss of senior technical professionals as companies are forced to downsize rapidly serves to limit mentoring young professionals, and has been of great concern as well, as we move well into the 1990s. This human resource loss will cut across the fabric of our industry if it has not already, and limit our real potential for future success and leadership. These jobs we are now referring to in the aerospace industry, are not only the engineering and scientific skills, but the production, operations, insurance, finance, marketing, and related fields as well: all vital to insuring success in a competitive marketplace.

SPACE

The new global marketplace has demanded "the best" in telecommunications, earth sensing, terrestrial technologies, advanced power sources, and advanced communications to stay competitive. The nation which controls access to space and associated infrastructure assets (e.g. satellites) will be positioned to develop the future harvest of space and all the added benefits society receives as a pioneer in needed critical programs for global leadership. The success the United States has achieved to date could not have happened without investments in scientific and technological research. If the United States is not a dominant player in developing the technologies and infrastructure required to conduct scientific and technological research in space, there is little doubt that the future marketplace will be controlled by others. To capture the marketplace of the 21st century, is to continue to invest in this national technological resource now.

Scientific Research

We are extremely concerned about the impact of decreased funding for apace science Missions Operations and Data Analysis at NASA. This policy will result in inadequate scientific analysis of data from the missions, and even premature termination of functioning scientific satellites. Current plans in the Astrophysics Division for 1994 call for reviews of 16 active programs with the objective of severely reducing virtually all of them and possibly canceling several entirely. The motivation is entirely budgetary; all f these programs are producing excellent scientific return. This policy is wasteful in that the cost of continued satellite operation is a small fraction of the initial development, fabrication, and launch costs. The purpose of building these instruments is to gain scientific knowledge. As noted in a recent Congressional Budget Office study, "[t]he typical NASA project incurs large annual costs

early in its project life but delivers most of its benefits later during the operating and data analysis phase, a period of relatively smaller annual costs."[1] Turning them off before they have achieved their full potential is neither financially nor scientifically sound.

Student Development Research Program

The U.S. civil space program got its start with the competitive motivation of national status. By leveraging the academic and industrial base we achieved number one status in the world with our accomplishments. Now economic, political, and social conditions have changed, leaving our space program in a condition of gridlock. One possible avenue to involve students in scientific research is through the proposal to develop and launch three small science missions on refurbished Minuteman ballistic missiles. This concept offers a fresh approach to stimulate interest in the younger generation for space research and would constitute proof of concept for an expanded program of several launches per year for a broad section of U.S. universities. Students would design, test, and operate these missions with industry support in a 2-3 year time frame. Participation of entry-level professionals should be encouraged, and universities should develop an academic curriculum around these missions to attract and train future scientists and engineers.

Access to Space

The fundamental building block for any space program is the launch capability that provides access to space. The White House, NASA, DoD, and the aerospace industry recognize that the nation's space launch capability is "troubled." Our space launches require enormous numbers of engineers and highly trained personnel, frequently cannot be held to schedule, do not achieve desired levels of flight success, lack the flexibility to be reprogrammed on short notice, and are very costly. To continue operating an increasingly aging U.S. space transportation fleet that imposes high costs and poor dependability on its users and thereby fails to meet the growing challenges posed by the non-U.S. launch service providers is not an attractive option. The consequences of such a policy are far more serious than just the loss of the U.S. space transportation industry, which in itself would be a major blow to the economy.

National requirements for space launch include civil, military, and commercial missions. Investments in the technologies, systems, and infrastructure for civil and military mission would directly benefit commercial interests. Conversely, a healthy commercial industry also would bring reduced costs and better operability to civil and military users. Moreover, such government investment would stimulate additional private-sector investment and improve U.S. commercial competitiveness in world markets.

Space launch does not have to be inefficient. Many large aircraft and missiles are highly complex, both mechanically and electronically, and like space launch systems, are very costly. However, once operational, they require relativelv few technical-level personnel to "launch" them. In contrast it takes many hundreds or thousands of engineers and technicians to execute a space launch. Aviation was risky, costly, and operationally inefficient for the first few decades. Then the aviation industry and the government set about improving dependability and inefficiency.

During the past decade a series of blue-ribbon commissions, committees, and panels proclaimed the need for a consistent, comprehensive apace launch policy aimed at correcting these deficiencies. The President and Congress, in close consultation with U.S. industry, must formulate and implement a comprehensive national space launch policy which stresses the cost effectiveness, dependability, and efficiencies that characterize other transportation operations. Unfortunately, the technology and market for space launch lack the maturity enjoyed by automotive, marine, and air transportation. Nevertheless, the need for space transportation is certain to row, as will the global competition. A comprehensive national policy is, therefore, essential to plan for and to guide that growth and its attendant challenges. Efficient, dependable space launch capabilities will be essential to ensure America's future international competitiveness.

Many of these issues are addressed in a recent AIAA paper entitled, "America's Space Launch Capabilities."

Long Lead Technologies

Budget pressures have forced NASA to put on hold most of its exploration plans for the Moon and Mars. Unfortunately, key long-lead technology programs associated with such programs have also been put on hold. Our concern is that these tech-

[1] "Reinventing NASA," Congressional Budget Office, page 13, March 1994.

nologies will be lost as programs are shut down, facilities are closed, and key people leave or retire.

For example, plans usually have requirements for space nuclear power or propulsion systems, and so investments in these technologies have, for the most part, been terminated in both civil and defense sectors. Hence, the availability of radioisotope fuel for future robotic deep space probes is not certain because of the need to obtain the basic material from foreign sources since U.S. production has ceased. This could compromise, if not preclude, the continued exploration of the outer planets that was begun so spectacularly by she radioisotope-powered Pioneers and Voyagers. Moreover, as work on space reactor-based power and propulsion systems is terminated, that infrastructure is being lost with few prospects in sight for maintaining core capabilities for the future. Thus, when the nation turns its attention back to the manned exploration of the Moon and Mars, we will pay a high price for "re-inventing" a broad data base and restoring a large infrastructure. We recommend that these issues be considered as you make difficult choices about the future direction for the nation's research and technology base, and our long-term ability to explore and learn about the Universe we live in.

International Cooperation

Consideration of the use of the space technology, production facilities, and operational infrastructure of the nations that were formerly Soviet republics is motivated by foreign policy, technical, and economic considerations. Pursuit of these goals offers great opportunity, but also considerable risk. These goals are also coupled, necessitating a careful balance to avoid introducing unacceptable risk in any resulting joint programs.

Given that the new post-Soviet governments are still unstable, it is important to formulate cooperative programs that avoid excessive risk to our own investments and technical objectives of the other governments or their following guidelines constitute a minimum list to consider when formulating new cooperative ventures with the former Soviet republics. Their application should help assure a more productive working relationship with these new nations by limiting our risk and thereby reducing the possibility of unwanted tensions.

- Carefully assess the short-term and long-term viability of each post-Soviet production or operational facility that we would utilize in cooperative ventures.
- Assure that our own contributions to major initiatives can be selfsupporting if the contributions of the former Soviet republics are not fully realized.
- Establish periodic deliverables from both sides that incrementally add to overall system capability and provide an ongoing basis for close cooperation among all parties at the working level.

International Space Station Alpha

The AIAA continues to strongly support the assembly and operation of a space station as an essential element of America's future civil space program. The International Space Station Alpha is designed to provide engineering and technical capabilities that make possible the long-duration "hands-on" laboratory experiments needed to understand the space environment and to gain experience in on-site space operations. The Space Station will open up an entirely new dimension to our study of biology, physiology, and -materials sciences. In addition, an international space station can provide an environment for advancing, testing, and demonstrating infrastructure technologies such as automation and robotics, innovative structural design and dynamics, and systems needed for on-orbit operations.

The AIAA also supports an international space station as a legitimate, useful mechanism for achieving America's broader foreign policy objectives, tncluding the development of U.S.-Russian relations in a post-Cold War era. Our nation's civil space program was born as a tool of foreign policy during a period of superpower competition. It is fitting, therefore, that we look to our science and technology programs, in part, as elements of our foreign policy objectives, but with a theme of cooperation rather than competition.

The knowledge that we will gain from cooperation in areas such as integration, standardization, management, and useful technology interchange will help to lay the foundation for a rich menu of future international space projects. This knowledge will not only enhance future cooperative ventures; it will also sharpen our competitive stance in the global economy.

AERONAUTICS

We have two basic messages in aeronautics. First, NASA has in place an aggressive, multi-year research program to make the U.S. more competitive. The FY95 budget request is a continuation of the high-priority research initiated by the Con-

gress and the Administration in FY94, except for the sharp decrease in support proposed for the aeronautics research and technology (R&T) base, which is clearly a step in the wrong direction in the context of future U.S. competitiveness.

Second, emerging new technologies provide the potential for increasing the air system capacity and operational efficiencies while improving safety. To attain this potential, however, affordability considerations dictate the need for change. There is an urgent need for a national air transportation strategy that provides a basis for compatible technology and business decisions.

The NASA aeronautical program initiated in FY94 and continued in the FY95 budget request is directed at conducting research and validating selected high-leverage technologies in both subsonic and high-speed regimes, as well as improving and augmenting aeronautical test facilities. The program s ultimate goals are to reduce the development and operating costs of the U.S. aviation industry, to improve world market penetration, and to ensure U.S. leadership in collaborative efforts with other nations.

Advanced Subsonic Technology (AST)

The key challenge is to provide for continuous improvement in efficiency, environmental compatibility, and affordability (value added) of U.S. aircraft and in the capacity and safety of the national air transportation system. These areas of interest apply to all sizes and types of aircraft and their associated propulsion systems: large transports, regional and general aviation aircraft, and rotorcraft.

The specific elements of the AST research and technology plan, when implemented, will enhance the continued competitiveness of U.S. aeronautical products. For example, one of our domestic airlines suggests that airlines could save $1.3 to $1.6 billion annually if "direct-to" routes could be used and airport taxi delays eliminated. The AST program's terminal area productivity element addresses many of the issues involved in achieving this saving. Another example: the more efficient, lower-emission engine technology addressed by the AST program has the potential of reducing oil demand by an estimated million barrels per day, which translates to about $6 billion annually.

The AST program's efforts on short-haul systems should also be noted. As more and more airports and their surrounding airspace approach their saturation points, the relative importance of vehicles capable of vertical takeoff and landing (VTOL) is likely to increase. The AIAA supports NASA's work on innovative VTOL technologies and encourages continued coordination between NASA and the FAA in civil VTOL aircraft and system studies.

The noise and emission reduction technologies being addressed by the AST program are particularly important to the future competitiveness of U.S. commercial aircraft because of the expected forthcoming intensification of environmental requirements by many nations, airport authorities) and the International Civil Aviation Organization (ICAO).

In sum, the AIAA strongly supports the Administration's recommended growth of the AST program budget from FY94's $89.3 million to $125.8 million, and commends NASA for its coverage of all sizes and categories of commercial aircraft.

High Speed Research

NASA's High Speed Research (HSR) Program is focused on developing precompetitive technology for a new environmentally and economically sound supersonic transport aircraft, referred to as the High-Speed Commercial Transport (HSCT). Because of the high technical risk of HSCT development and the current state of health of the aircraft industry, NASA's HSR program is essential to ensure the existence of a U.S. HSCT option.

More than half of the HSCT sales will be to foreign countries, thereby protecting the U.S. trade balance. Despite the current downturn in airline seat-miles, we believe that the projected traffic growth, especially in the burgeoning Pacific rim market, still has the potential of generating over $10 billion (500—1,000 supersonic transport aircraft) in annual sales of HSCTs well into the next century. This represents over 100,000 high-value jobs for U.S. industry. A loss of HSCT leadership to a foreign competitor would severely impact the market for subsonic transports currently dominated by the U.S. and lead to a loss of up to 160,000 jobs, with a major impact on U.S. balance of payments. Europe (having built the Concorde), Japan, and Russia are beginning to focus resources towards an HSCT. The HSR program lays the foundation for U.S. leadership. Any delay in proceeding with the HSR program substantially increases the risk of losing this leadership position.

The AIAA therefore supports the proposed increase in the HSR budget from $197.2 million to $221.3 million, and encourages the U.S. government to continue the relevant technology development through scheduled completion in 2001.

Research and Technology Base

The R&T base is the essential element in opening new opportunities for future aeronautics advances that will contribute to improved performance, enhanced safety, reduced costs, higher reliability, and better operability of U.S. aviation systems. The seeds of tomorrow's competitiveness for the U.S. aviation industry lie in the NASA R&T base. We therefore believe that the proposed cut in R&T-base funding from $418.3 million to $342.8 million is a step in the wrong direction. The next generation of systems technology programs that will follow the HSR and AST programs will come from the R&T base. It is the source of the expertise needed to solve the problems we cant foresee in the near term. This is clearly an area that deserves as much growth as we can afford.

Wind Tunnel Facilities

The average age of U.S. wind tunnels is approximately 40 years, and they were designed primarily to conduct basic research rather than to evaluate or validate the effectiveness of new technologies in aircraft systems. Competitor nations have been investing both voluminously and steadily in new wind-tunnel facilities. Hence U.S. aeronautical engineers and designers are at a distinct disadvantage.

The U.S. needs state-of-the-art, highly productive national research and development test facilities. Industry must play a major role in their design, development, and construction. The AIAA supports the current proposal for a government-industry consortium to undertake this important effort, as well as the funding required for its timely implementation. We hope the $74 million appropriated last year for the ongoing studies of two new National Wind Tunnels will evolve into substantial support for initiation of these projects in FY96.

National Policy and Strategy for a 21st-Century Air Transportation System

The U.S. economy is highly dependent on a safe, efficient air transportation system. Yet, there is a growing imbalance between capacity available and capacity required.

Traditionally, technology advancements have been applied to discrete segments of the transportation system (air traffic control [ATC], the airplane, airline operations, etc.) with limited coordination among the various stakeholders (airlines, FAA, airplane manufacturers). This approach worked in the past because of the relative independence of the various system elements (the airplane, airports, ATC, etc.). However, the air transportation system has evolved to a state in which this independence is being eliminated.

A major barrier to the effective recognition of the benefits of advanced technology is the lack of an overall commercial aviation strategy that focuses the stakeholders' efforts. The AIAA therefore suggests that the administration establish a government-industry executive body, with strong representation of the airlines and other system users, to define a national air transportation strategy.

Maintaining Aeronautical Leadership

The U.S. aerospace industry has suffered multiple blows since 1989. The proposed FY95 NASA aeronautical R&T budget will provide the technology investment needed to reverse that trend. Without that investment in technology, there is little hope of stemming the current decline in exports and the accompanying loss of jobs. The AIAA therefore endorses the NASA aeronautics R&T Program, and recommends that you support it.

PREPARED STATEMENT OF DR. GLENN MASON, PROFESSOR, DEPARTMENT OF PHYSICS, UNIVERSITY OF MARYLAND, ON BEHALF OF THE SPACE SCIENCE WORKING GROUP, ASSOCIATION OF AMERICAN UNIVERSITIES

Thank you for the opportunity to submit testimony to the Senate Subcommittee on Science, Technology and Space. The Space Science Working Group of the Association of American Universities represents several hundred space scientists at approximately 50 universities nationwide. Our membership embraces al space science disciplines represented by NASA's Office of Space Science (OSS), its Office of Life and Microgravity Sciences, and its Mission to Planet Earth Office. Our analysis of the NASA FY95 budget request focuses on university-based space science research and the associated impacts on U.S. leadership in science, graduate and undergraduate education, and technology stimulation.

THE NASA BUDGET

The NASA FY95 request of $14.3 billion is a decline of $250 million from the current year—the first real shrinkage of the nation1s civilian space program since the early 1970's post-Apollo era. At a time when the nation needs to invest in its future and to undertake challenging and visionary programs that inspire our citizens and energize our youth, we are concerned about the declining support of the space program. We believe that a vigorous space program is a vital element in our national strategy tor pursuing economic strength with a highly trained and motivated workforce pursuing high technology enterprises. We reaffirm tee Augustine Commission's finding that space science should be the centerpiece of the space program due to its broad-reaching impact on the young, and on U.S. world leadership in science.

THE NASA SCIENCE BUDGET

We believe that commitment to completing current missions is of the highest priority. After several years of severe budgetary constraints, the FY95 Space Science budget is a commendable continuation of previous efforts in the major missions. We applaud the recognition of the importance of science evidenced by the budgetary increases proposed to maintain the major flight programs close to schedule, even during a time when the agency budget as a whole is declining. The Cassini and AXAF missions proceed on schedule after their downsizing with the prior loss of the CRAF and AXAF-S missions. The lSTP Wind and Polar spacecraft is nearing completion, despite a recent slip due to problems with the spacecraft. The Earth Observing System (EOS) continues its ramp-up, although at somewhat less than the planned pace. The restructured International Space Station Alpha has the potential to carry out the originally planned Life and Microgravity science goals, although lack of definition in the program is a cause of increasing concern. Smaller flight programs in the Discovery, Explorer, and Earth Probe series, and the Relativity Mission (formerly known as Gravity Probe-B) continue their orderly development.

Several aspects of the current budget and planning process at NASA cause us great concern, however. These arise from the deteriorating budgetary picture along with recent management changes within the Agency. Specifically, we recommend that NASA:

- complete its reassessment of the "Woods Hole" scientific strategy, publish a scientific strategic plan coordinated with the scientific community, and begin technology developments to implement the plan using smaller, less expensive missions thus assuring frequent access to space;
- forego its proposal to shut down spacecraft in the outyears before they have realized their full scientific potential through extended missions;
- reinvent the agency approach to mission operations (MO) by trading higher risk levels for lower cost in order to make more resources available for extended missions and new missions;
- reverse the inflationary decline in the competitive grants program (R&A) and suborbital missions so essential to university research and training; and
- in accordance with recommendations contained in the Senate FY94 VA-HUDIndependent Agencies Appropriations Subcommittee report, reconvene the Augustine Commission to reexamine the role of Space Science in view of the changed budgetary situation and urge the National Academy of Sciences to undertake a study of NASA space science management.

Strategic Planning: The splitting of the former Office of Space Science and Applications (OSSA) into three offices—Office of Space Science, Mission to Planet Earth, and Life and Microgravity Sciences and Applications—and setting aside the OSSA Strategic Plan has made it difficult for the scientific community to construct an overarching plan, particularly in missions that have multi-disciplinary components. Budgetary pressures for much smaller missions, along with modifications of the Space Station design, have increased the difficulty of creating an exciting and challenging world-class science program. In recent months, NASA advisory committees have been creating a new scientific strategic plan that contains many or most ot the priorities previously identified, but whose implementation is consistent with smaller missions and the redefined Space Station. Given the long lead times for mission development, and the lead times for developing technologies optimized for smaller spacecraft, it is essential that the agency publish its plan and move forward with the task of technology and instrument development required to carry it out. For the past few years, advanced technology development activities have been minimal. This situation needs to be reversed.

Extended Missions: NASA procures spacecraft with "guaranteed" lifetimes that are based on issues of redundancy and cost rather than science. This results in missions with "minimum" lifetimes having iittle to do with the scientific goals or excel-

lence of the research. In current NASA planning, all spacecraft extended missions are unfunded, and the plan is to shut down each spacecraft as soon as its "guaranteed" lifetime is reached. This scuttling of the nation's spacecraft fleet would be a scandalous waste of the nation's investment in spacecraft, and would quickly devastate the scientific community since new measurements are its lifeblood. One need only think of the Voyager pictures of Neptune and Uranus or the Pioneer pictures of Saturn to grasp the startling and beautiful results that have come from extended missions. Although no missions are slated for turn off in the FY95 plan, in the following year, the shutdowns begin with the IUE spacecraft, and the SAMPEX and international Ulysses missions. It would be hard to overstate the disastrous impact of this plan on the space science community.

Reinventing Mission Operations (MO): Mission operations are a large and growing portion of the NASA Space Science budget, due to the high launch rate of recent years. NASA space flight missions are operated with extreme conservatism compared with commercial spacecraft operations, and costs are driven much higher by layers of redundancy and a desire to retrieve virtually 100 percent of the data from a spacecraft, even though the scientific goals of the mission may not require this. The situation is exacerbated by the Agency's past emphasis on preiaunch c6sts, and a management structure that decoupled much of the tracking costs from the data analysis effort. We applaud the recent initiatives at NASA to address this situation by removing layers of redundancy as well as by using high-technology automated ground stations. Much more needs to be done.

An interesting example of what can be achieved with a fresh approach can be seen in the operation of the highly successful Japanese Yohkoh spacecraft, which is not tracked on weekends or holidays in Japan. This sort of approach results in huge cost savings and could be applied in many cases to U.S. spacecraft. We believe that the scientific community is ready to help here by embracing lower data retrieval rates, and by accepting higher levels of risk (e.g., by having fewer ground contacts), particularly in the extended mission phase.

Competitive Grants (R&A) and Suborbital Missions: Last year the Space Science Working Group called for a restoration of the erosion in the competitive grants program (R&A). We are keenly disappointed that the FY95 R&A budget is flat in current year dollars—that is, it decreases at the rate of inflation—and this flat budget remains in place through the end of the decade. In the Life Sciences area, there is actually a $15 million decline this year since the Aerospace Medicine program was moved into the R&A line without an accompanying funding increase. The University community depends vitally on the R&A line and the suborbital program to support individual investigators and students; both provide the foundation for education, research, and the development of future missions. These programs provide the basis for asking the right questions for future flight missions, and often are the sources of the enabling technology for such missions.

While the R&A and suborbital lines are extremely dynamic programs in which funds are fiercely competed, and in which new ideas can gain support. Young, new principal investigators can enter into space research almost solely on the R&A line, and their fresh ideas form a crucial component of the grants selected for funding. The suborbital program has flown over 2600 sounding rockets and large numbers of balloon payloads over the years. Since R&A grant durations are short (2-3 years), this program is constantly identifying and supporting bold new initiatives, making it perhaps the most efficiently used funding line in space science research. In the suborbital area, the relatively modest costs of each mission make it possible to experiment with new. risky technologies. We urge the Congress to reverse the decline in the university research and training supported in the R&A and suborbital programs by adding an inflationary increase this year (about $9 million for OSS, MTPE, and LMGA R&A; $3 million for suborbital) and instituting a plan for at least inflationary increases in the out years.

Reconvening the Augustine Commission: The Augustine Commission, a distinguished group of industrial, academic, and congressional leaders, conducted a broad survey of the civilian space program, then issued their Report of the Advisory Committee on the Future of the U.S. Space Program. This 1990 report contained numerous thoughtful and insightful recommendations and made this panel the most successful and respected of recent groups surveying the space program. Their call for a balanced space program in which "the space science program warrants the highest priority for funding" was based on the unique potential of the science program to "enable basic discovery and understanding, * * * uncover the fundamental knowledge of our own planet to improve the quality of life for all people on Earth, and stimulate the education of the scientists needed for the future." The Space Science Working Group believes that the conclusions of the Augustine Commission are as valid today as when made several years ago. However, the changing budgetary envi-

ronment and new Administration warrant a revisiting of this issue. Therefore, we urge a reconvening of the Augustine Commission. Also, because of the importance of science management within NASA, we support the congressionally mandated and funded National Academy study of the desirability of creating a national institute of spa ce science within NASA.

We now consider issues in the three science offices in the NASA program:

OFFICE OF SPACE SCIENCE (OSS)

The major flight development programs, AXAF and Cassini, are fully funded. We commend the agency for keeping these development activities on schedule, instead of stretching them out for near term savings but eventually much larger cost. The Relativity mission (formerly Gravity Probe-B) has ramped up to a $50 million "level of effort" activity with launch anticipated around the end of the decade. The Planetary Discovery missions (NEAR and MESUR) received full funding—keeping these small, quick development programs on schedule. The Explorer program continues the development of several missions (XTE, ACE, FUSE, and the small Explorers FAST and SWAS). The small downturn in funding is unfortunate since this program has long been the pioneer program for small spacecraft that are especially important to the university community.

Since submission of the Administration's budget, a serious problem has emerged in the Global Geospace Science (GGS) program's Wind and Polar spacecraft. It was discovered that power subsystems in these spacecraft have identical engineering weaknesses to those involved on the NOAA and Mars Observer spacecraft—both of which were lost last year. Replacing thesepower "boxes" will delay the launches and add $30-50 million to the cost of the program. NASA is considering cancellations in this program, which would write off the prior investment of several hundred million dollars. This would be a disaster for the solar-terrestrial research program for which these spacecratt are the centerpiece. Since the problem in this case rests squarely on the shoulders of the spacecraft contractor, and since it involves a standard spacecraft component, it would be grossly unfair to decimate an entire scientific discipline by cancellation. The SSWC gives the highest priority to completing these two spacecraft for launch as soon as possible.

Last summer the Mars Observer spacecraft failed, shattering plans for a broad scientific survey of the planet. The failure was a major setback for the planetary research program, and a vivid reminder of the risk associated with any space flight venture. The FY95 budget contains an excellent initiative—the Mars Surveyor—to recover many of the lost Mars Observer goals using back-up instruments and smaller spacecraft. Very much in keeping with the smaller spacecraft initiatives, this approach will also have the advantage of spreading the risks over several spacecraft. An added bonus from the program will be the establishment of an orbiting communications link at Mars that will allow significant cost savings for follow-on missions since they will need only to broadcast to a nearby spacecraft and not directly to Earth.

The Outyears Problem in the Office of Space Science: Although the FY95 budget request provides the funds to carry out the previously existing programs in OSS in an orderly manner, the agency's multi-year plan reveals that the astrophysics, planetary, and space physics research program is essentially shutting down. As AXAF, Cassini, MESUR, NEAR, and the Relativity missions complete their development no new starts are planned. By the end of the decade, the only new initiatives would be in the Explorer line, the Hubble servicing missions, and the Mars Surveyor missions. The existing spacecraft fleet is planned to be turned off as soon as prime missions are finished—that is, much before the scientific potential has been achieved. The competitive grants (R&A) programs and suborbital programs so vital to the university community would remain flat, and would thus lose purchasing power to inflation and make it exceedingly difficult for young people to enter the field.

The SSWG is deeply concerned with this scenario, which in effect reverses one of the prime recommendations of the Augustine Commission. The reversal would lead to the termination of the "outward looking" science programs in NASA that seek to understand our place in the universe, our solar system and its planets, and our link with the sun and heliosphere. We are at a loss to reconcile this plan with a national agenda that calls for high technology initiatives, demonstrates the courage to take risks in order to explore and seekunde rstanding, and energizes our citizens, particularly the young, with the extraordinary visions and surprises that come from space exploration.

OFFICE OF THE MISSION TO PLANET EARTH (MTPE)

Following last year's massive restructuring and downsizing, additional funding pressures in the FY95 MTPE budget have significantly impacted mission development. The launches of both the AM and PM platforms are likely to slip by several months, and a number of critical sensors have been either deferred to later flights or eliminated. The FY95 budget reductions leave the program highly sensitive to any further reductions. The current budget allows no new starts in the Earth Sciences area and leaves the initiation of the critically needed gravity mapping and topography mapping missions In limbo.

Funding tbr Earth Probes showed a small decline as development of these mission elements matured. However, there are no continuation tends in the Earth Probe line, so when the currently funded missions are completed, the Earth Probe line will vanish. This is a very serious problem for future small science missions and for the initiation of a number of important intermediate size missions.

In the Landsat program, it is essential that the $90 million increment of Air Force funds to support the follow-on mission be transferred to NASA, along with the responsibility for implementing the program. If this budget increment is not provided, and is taken from other MTPE funds, it will have a disastrous effect on the existing Earth sciences programs.

OFFICE OF LIFE AND MICROGRAVITY SCIENCES AND APPLICATIONS

Last year's redesign of the Space Station produced the "alpha" station (without Russian involvement), which appeared adequate for the primary life and microgravity science. Later, the International Space Station design (with Russian involvement) had greater capabilities that met all life and microgravity user requirements, but with large uncertainties. For example, in the orbital inclination required by the new program, shuttle launch windows on optimum days are only 5 minutes long, and are considerably shorter at other times. Weather patterns alone at Cape Canaveral make it difficult to launch in such short windows. There is concern in the community that activities needed in support of the Space Station (e.g., furnaces, glove boxes, centrifuge, animal holding facilities) remain underfunded.

There is a major concern about the shift of emphasis almost entirely to Mir and related activities. she giving up of Spacelab flights to fund trips to the Mir space station will set back the pace of scientific research on humans in space since the research environment and data taking capabilities on Mir are much less sophisticated than on Spacelab. While up to 2 man-years of exposure will be achieved, the amount of new knowledge to be obtained will be limited. In microgravity investigations, with only a few exceptions, all experiments for several years must be designed and built with the objective of flying for extended periods on Mir or in mid-deck lockers on shuttle service flights. The latter will generally be of short duration and not optimally configured to provide the best microgravity environment or research framework. For U.S. researchers, Mir is an unknown and untested program, and what little information is available from Russian and European colleagues, and from NASA, is not terribly encouraging. In addition, Mir activities have appeared very suddenly, and so the scientific community has had little time to prepare, modify, or reconfigure ideas and hardware. R&A and instrumentation funds to support Mir activities are not appearing. Scientists are being asked to do Mir experiments with funds originally targeted for other efforts. Overall, there is great concern as to whether it will be possible to carry out high quality scientific studies on the Mir platform.

The Research and Analysis (R&A) activities increased the emphasis on peer review this past yearl a highly commendable move that will help ensure that the best scientific ideas are supported. The addition of Aerospace Medicine has caused a 15 percent reduction in base activities.

THE PAST YEAR IN REVIEW

Despite the Mars Observer and weather satellite losses, the past year has seen many exciting new results in space science. The dramatic repair of the Hubble Space Telescope (HST) captured the interest and imagination of millions of citizens and was closely followed by the media worldwide. More dramatic still were the spectacular photos of galaxies and stars released following the repair mission, and the anticipation for many years of spectacular discoveries as HST explores a new universe revealed with unprecedented clarity. The International Ulysses mission, having received its orbital kick from Jupiter, soared out of the planetary (ecliptic) plane and will carry out the first reconnaissance of the sun's polar regions this summer. The highly successful SLS-2 flight showed that unique insights into physiological

and biological processes such as blood flow and the human balance system can be obtained in microgravity settings. The Japanese-US ASCA x-ray astronomy mission has already made a number of exciting discoveries including the first detection of emission x-rays from a supernovae. The aglileo probe discovered the first moon orbiting an asteroid (Ida). The TOPEX/POSEIDON mission is producing global views of the ocean with unmatched resolution, and the UARS program continues to provide new and valuable information on the Earth's atmosphere. Both TOPEX/POSEIDON and UARS are establishing critical baseline measurements for NASA's contribution to global change studies.

QUESTIONS ASKED BY SENATOR BURNS AND ANSWERS THERETO BY MR. GOLDIN

Question. The FY 1995 budget request for NASA is $14.3 billion, a $250 million decrease from the current year level. This is NASA's first requested decrease in funding since the end of the Apollo program in 1974. What factors went into NASA's asking for a decreased funding level for FY 1995?

Answer. NASA submitted a budget to the Office of Management and Budget of $14.3 billion, the same level that the President had requested for the agency. This budget request reflects the economic challenges and fiscal reality of limited federal resources.

Question. NASA has said that the current budget request cannot get "any closer to the bone." Do you share that view? Given NASA's historical difficulties in working within budget, how will NASA cope with a funding cut?

Answer. The NASA budget request of $14.3 billion for FY 1995 supports a balanced space and aeronautics program that supports meaningful science, aeronautics and technology activities, but at the same time is responsive to the reality of constrained federal resources. Over the past two years, NASA has conducted an aggressive and thorough review of its programs and institutional operations, and as a result has reduced its budget requirements by 30 percent through FY 1999. This reduction reflects concrete plans that are being implemented to ensure that the budget savings are realized. These plans include major restructurings of NASA's major programs, including Space Station, the Cassini mission to Saturn, the Earth Observing Satellite (EOS) program, the Advanced X-Ray Astrophysics Facility (AXAF)-S mission, and the Gravity Probe-B mission. Funding requirements for the Space Shuttle have been significantly reduced by consolidating activities, implementing operating efficiencies, and aggressively examining manpower requirements. Requirements for support contractor support, information resources management, Construction of Facilities projects and institutional operations have also been reduced. Planned civil service levels in the outyears have been reduced. The actions to implement these reductions are underway, and the savings resulting from implementation have been incorporated into the outyear funding projections.

I strongly believe that NASA cannot deliver a balanced and meaningful space and aeronautics program if the budget is cut below $14.3 billion. Human space flight activities, including the Space Shuttle and Space Station, cannot sustain any further reductions. Funding for science and technology activities are investments in our future, and are vital to the competitive future of the United States. NASA's Aeronautics program is focused on maintaining the proper technological base to maintain America as a leader in the aeronautics industry. NASA has taken its share of large cuts and is reshaping itself to do business in a new way. Stability in funding is paramount to NASA's ability to deliver a quality program that makes sense for the country.

Question. Like the FY 1994 request, with one exception (the Mars Surveyor), the FY 1995 request proposes no new starts. Is this a sign of NASA's renewed commitment to work within current fiscal realities?

Answer. The FY 1995 request does include funding for a limited number of new activities initiated in FY 1994. As you note, funding is included to initiate a series of small spacecraft to conduct a detailed exploration of Mars. Funding is included to continue development of the first two Discovery missions, the Mars Environmental Survey (MESUR)/Pathfinder and the Near Earth Asteroid Rendezvous (NEAR) missions. Funding was provided by Congress to initiate these in FY 1994. Funding is also included to fully implement the expanded program of cooperative activities with Russia. This includes up to 10 visits to Mir by the Shuttle and a supporting program of experiments and research in life and microgravity sciences. Funding for the New Technology Investment program, which was initiated in FY 1994, is also continued in FY 1995. This program of technology developments, led by the private sector, will result in a number of technology development and application projects. Other proposed new starts for FY 1995 include two Space Shuttle

projects, the superlightweight external tank and the main engine health monitoring system. Budget constraints preclude starting other new projects at this time.

Question. How do we make NASA more relevant to the U.S. economy and how do you explain the significance of our space program for example, to small businessman in Billings, Montana?

Answer. The space program has long played a role in boosting the U.S. economy through the development of cutting-edge technology. Americans are still reaping the benefits of the Apollo years in term of technological payoffs. A perfect example of this is the ultra-reliable software NASA has to develop as part of going to the Moon. Now, it is everywhere—it is part of our digital phones, automatic teller machines and a tool for automobile design. The benefits of NASA incentives and technology are diverse. NASA is making critical contributions to the U.S. technological base and economy.

Today, NASA activities continue to play a vital role in developing profitable technologies. For example, NASA is a leader in the area of remote sensing. This holds tremendous potential for the U.S. economy. Today, the worldwide market for remote sensing is about $800 million, but growth in applications such as land management, environmental compliance, agriculture and urban planning and development have been predicted to boost this to $8 billion in the next 10 to 15 years. NASA's work has also been critical to the U.S. satellite communications industry—another multi-billion-dollar world market. Commercial transport aircraft is also a tremendous market, and NASA plays a key role in this area as well. While the U.S. share of the global commercial transport market has slipped to 67 percent, we believe that the continued joint work of NASA and industry can increase that share to 75 percent. Market projections are greater than $800 billion through the year 2010.

NASA works closely with the industry on a wide variety of projects and has made diversifying its contractors a high priority. For example, NASA had a goal of awarding 8 percent of the total value of Agency contracts to minority- and women-owned businesses by i994. We beat that goal, reaching a level of 8.5 percent in 1993.

Question. I am aware that NASA is very committed to streamlining its operations by reducing civil service and contractor personnel and eliminating redundant management structures. Is that streamlining effort reflected in the budget request?

Answer. The FY 1995 budget request includes savings from actions which are underway to reduce the cost of operating the NASA institution. These reductions include reductions in funding for information resources management, support contractors, construction of facilities projects, civil service staffing levels, and institutional support.

Question. In the past, questions have been raised about NASA field center's lack of accountability to headquarters. How has that problem been addressed so that policy decisions made at headquarters are promptly implemented at the NASA field centers?

Answer. A new policy and Plans unit is being established within the Office of the Administrator that will be responsible to lead the analysis, formulation, dissemination and implementation of Agency-level policy and strategic planning activities and issues. The unit will provide executive leadership and ensure coherence and consistency for Agency policy issues and functions in the following areas:

Directs, conducts and coordinates analyses and activities to identify Agency policy needs, investigates alternative policy strategies and develops compelling rationales for NASA's programs and plans.

Establishes and facilitates a process to formulate and integrate overarching Agency policies in response to internal and external factors.

Assures and facilitates the implementation of cross-cutting Administration, congressional and Agency policy directives within the program offices and field centers.

Disseminates relevant information to lead policy contacts in program offices and at the Centers.

The final proposal to implement this unit within the Administrator's office is currently in the concurrence cycle and is expected to be formalized by the end of May.

Question. The newly redesigned Space Station calls for full participation by the Russians in the program. In fact, five of the first seven Station-related launches are Russian launches of Russian hardware. Do you believe there is over-reliance on Russian hardware and launches in the new Space Station plan? Are you confident that, if the Russians drop out of the program, for whatever reason, the U.S. will still be able to keep the program on track?

Answer. NASA believes the Russian capabilities will have a tremendous pay-off for the United States. Immediate pay-offs will come from the MIR missions which will provide extremely valuable on-orbit experience, as well as, knowledge transfer from the Russians. They have been operating the MIR space station safely since

1986. They have knowledge about safety issues, gleaned from long-term experience in space, that we simply do not have. In addition, Russian involvement in the Space Station will provide a more robust and safer Station while saving money and schedule.

To protect our vital interests, NASA has established specific contingency plans that will provide the capability to implement this program without Russian partnership should circumstances so dictate. We have prepared several program alternatives affording the U.S. the ability at various stages in development to continue this program independently without Russian participation. In developing these "off-ramps", we are responding to legitimate concern that the plan for international Space Station not depend too heavily on Russian hardware and that the United States preserve the capacity to independently provide flight hardware elements which are currently planned to be provided by the Russians. These contingency plans take two forms: first, the independent provision of U.S. propulsion, guidance, navigation and control hardware which would replace Russian capability, if necessary; and second, provisions to be negotiated as part of our contract with Russia which will insure that we take possession of hardware deliverables in the event of voluntary or involuntary withdrawal of Russia from the partnership. It is important to point out that these scenarios are essentially parallel developments and will probably not fit within the $2.1 billion funding cap.

Question. Under the new Space Station, the Russians will be supplying significant amount of hardware. Are you concerned that the Russian involvement may, in effect, transfer some Space Station jobs for the U.S. to Russia?

Answer. The Russian participation does not result in a net loss of U.S. jobs. The annual budget for Space Station is still $2.1 billion.

The Space Station redesign had lowering of costs as a primary objective. The program was forced to make hard decisions. Therefore, NASA reduced both the contractor and civil service employment on the Space Station in conducting the initial redesign of the program. Under the redesigned program all contracts and subcontracts have been novated to the new prime, Boeing. There were only a very limited number of contracts canceled and this is offset by other expenditures within the annual $2.1 billion cap.

By including the Russian elements, the Program added back content and capability. Furthermore, the hardware that the United States will be procuring from Russia is already developed. Cooperation with Russia also allows the schedule for assembly completion of the Station to be accelerated from 9/03 to 6/02.

There are also benefits for U.S. companies from Russian participation. U.S. companies can expect to benefit from improved access to technologies and increased interaction (competitive contracting) between U.S. and Russian firms in a variety of aerospace technologies. This will increase high-quality jobs in both countries.

Question. NASA has indicated that Russian participation will save us $2.0 billion in Space Station costs in the long term. What is the basis for this cost assessment?

Answer. NASA estimated it would cost $19.4 billion to bring the Alpha Station to full capability in September 2003. The current estimate including Russian participation at $17.4 billion is $2 billion less. Although annual funding levels remain essentially unchanged, the inclusion of the Russian Space Agency allows the program to achieve full capability in 2002, reducing the total funding by one year (about $1.5 billion). The Program has also achieved neatly $1 billion in savings through use of the Russian provided FGB/Bus and the ACRV. This hardware savings, and minor changes and reestimates in science payloads and research, are partially offset by approximately $250 million in content transferred to within the $2.1 billion annual funding cap, and almost $400 million in increases required for acceleration and reestimates of development and operations costs. (See enclosure)

Question. Some Members of Congress have said that Space Station cannot be done within a $14.3 billion NASA budget and they have conditioned their support for Space Station on NASA getting a higher appropriation for the agency. What is your view of that position?

Answer. To meet the Administration's deficit reduction targets in this time of fiscal constraint, the federal government must make sacrifices. Therefore, NASA is constrained in its spending like every other agency and has been searching for new ways of conducting business. NASA has put together a balanced space program within the $14.3 billion budget with Space Station funding at $2.1 billion per year.

The redesign of the Space Station program achieved significant cost savings; which was one of the Administrations's major goals for the redesign effort. Since the redesign, the Space Station program has been budgeting to a target of $2.1 billion per year. The recent System Design Review, completed on March 23, 1994, resolved over 2,000 technical issues, giving us high confidence that we can complete the international Space Station on schedule and within this budget.

Question. In recent years, Space Station has been plagued with endless redesigns which have increased costs and eroded Congressional support. Has NASA finally settled on a design that it intends to follow through on?

Answer. NASA is moving forward with the international Space Station design. On March 23, we successfully completed a major milestone for the international Space Station. The System Design Review (SDR) was a comprehensive review of the requirements, configuration and the maturity of the station's technical definition. NASA now has a solid baseline with schedule and costs that maintain acceptable reserves within our annual budget cap of $2.1 billion.

The redesigned Space Station which expands the partnership to include Russia certainly provides us with a more robust and safer Station. That is the reason NASA, along with our other partners—Japan, Canada, and Europe—welcomed Russia into the project last December. Russian participation will save money, and will enable deployment of the Station in 1997. NASA is confident that the program has a high degree of design maturity, and that enhancements the Russians will bring to the program afford clear savings in terms of total cost and schedule, while preserving full U.S. control and leadership.

Question. Besides Space Station, the budget request provides: $150 million for cooperative ventures with the Russians; $100 million for NASA's lease of the Russian MIR space station; and $50 million for Shuttle modifications to enable it to dock with MIR. Is this money well spend? What are the expected benefits to the U.S. from these activities?

Answer. NASA believes Russian cooperation and capabilities will have a tremendous pay-off for the United States. Besides an earlier-completed international Space Station and the saving thus achieved, Russian hardware will also provide a larger pressurized volume. This will allow for more science to be conducted, more equipment to be installed, and a larger crew to be accommodated (six) to support science, engineering, and technology research efforts. The availability of Russian launch vehicles and crew transportation vehicles will provide greater flexibility during construction and operation phases, and will help to meet contingencies and emergencies if they arise. Phases 1 and 2 enable joint technology demonstrations which will result in significant cost savings over U.S.-only developed technology. The operational concepts developed and proven during these phases will result in a smoother transition to the International Space Station.

Question. The budget request for space science does not include any new starts. Moreover, the White House projects a flat science budget for 1996 and 1997, which will probably preclude new starts for that period as well. Does NASA's FY 1995 budget request signal any reduced commitment by NASA to space science?

Answer. The FY 1995 budget request currently before the Congress reflects a balanced space science program based on a strong foundation of past successes. This request will enable the completion of high priority space science programs; will assure a continuing stream of future discoveries and first-rate science results; provide for the recovery of critical science objectives; reflects major replanning and strategic efforts to meet zero-growth funding targets; and, incorporates a renewed commitment to supporting technology, education and the environment. It also provides the funding to purchase launch services to support our upcoming missions.

The FY 1995 request fully funds the Cassini mission to Saturn and the Advanced X-ray Astrophysics Facility (AXAF), while providing for the continued development of the Explorer program. The NASA Relativity Mission (Gravity Probe B) and the two Discovery program missions started last year (Mars Pathfinder and Near Earth Asteroid Rendezvous) are adequately funded. Mission Operations and Data Analysis (MO&DA) and Research and Analysis (R&A) funding are maintained at last year's level in order to continue operations and scientific productivity of our current missions.

In addition, the FY 1995 request provides new start funding for the proposed Mars Surveyor program, a series of orbiters and landers that will take advantage of launch opportunities about every 2 years as Mars comes into alignment with Earth.

This budget does contain management challenges, especially in the outyears. The absence of a sustained Space Physics program, and the projected lack of funding to initiate new moderate-sized space science missions after FY 1995 in the current proposed budget, are particularly worrisome. However, these challenges are not insurmountable and we look forward to working with the Congress to ensure the continued success of our Nation's space science program. The Office of Space Science, supported by NASA's Space Science Advisory Committee (SSAC), is in the process of evaluating how best to structure a comprehensive space science program that must operate in a flat budget environment. We expect that SSAC will complete their evaluation and submit their recommendations to NASA in the late Summer or early

Fall. It is premature to conclude, therefore, that there will be no major space science missions in the outyears. We will be working with the science community during the next few months to put together a comprehensive space science program that meets the management challenges laid before us by the Clinton Administration.

The cornerstones of our approach in the Office of Space Science will include the following:

1) Our highest priority will continue to be the completion of missions now launched or under development. We will establish a renewed commitment to living within defined cost and performance envelopes, while realizing the full science potential of our operating missions.

2) Where feasible, we will initiate new programs to maintain U.S. leadership in space science which will continue the rate of discovery and knowledge.

These new programs would serve the following goals:

- Provide frequent access to space for continued exploration and discovery (maintain the Explorer and Discovery level-of-effort programs; initiate the Space Physics Solar-Terrestrial Probe series of missions)
- Provide for major advances in the state of knowledge in space science (start an Astrophysics Infrared Astronomy initiative; start Pluto Flyby mission to complete the reconnaissance of the solar system)
- Provide for increased opportunities for international cooperation (determined by foreign agency priority and funding availability)
- Invest in the future of space science through research and technology development

Although ambitious, we remain optimistic that these goals are achievable in a balanced space science program.

Question. The Mars Surveyor is a new start for FY 1995 that is intended to replace the Mars observer spacecraft, which was lost in space. What are the goals of the Mars Surveyor mission and how does it compare with the failed Mars Observer mission?

Answer. The Mars Surveyor program is not a single mission, but rather a series of missions which constitute a comprehensive approach to Mars exploration over the next decade and beyond. It will recover the science of Mars Observer, while simultaneously developing the tools for robotic exploration of the Martian surface, a high priority science objective that was not part of the Mars Observer mission. The ultimate goal of Mars Surveyor is to complete the global characterization of the Red Planet's surface, meteorology, and atmosphere.

The Mars Surveyor program will begin with the development of a small orbiter that will be launched in November 1996. This orbiter is the first mission of a proposed series of orbiters and landers that will take advantage of launch opportunities about every 2 years as Mars comes into alignment with Earth.

The first orbiter will be small enough to be launched on a Delta expendable launch vehicle and will carry roughly half of the science payload that flew on Mars Observer. It will be provided by industry and will take 10 months to reach Mars, where it will be inserted into polar orbit and will begin its 2-year mapping operations in late January 1998. This spacecraft also will be used as a data relay station for signals from U. S. and international landers.

NASA envisions an orbiter/lander pair of spacecraft as the next in this series of robotics missions to Mars. The orbiter planned for launch in November 1998 would be even smaller than the initial Mars Surveyor orbiter and will carry the remainder of the Mars Observer science instruments. Additional spacecraft would be launched at subsequent Mars launch opportunities.

In addition, several characteristics of the implementation of Mars Surveyor will be significantly different. For example, Mars Surveyor will involve multiple orbiters and landers (MO was a single orbiter), all of which will be smaller than Mars Observer in size and mass. In fact, their smaller size will permit the early spacecraft to be launched on a Delta II expendable launch vehicle, while the later spacecraft will be even smaller and lighter and will be designed to be launched on the proposed Med-Lite vehicle (MO was launched using a Titan III/Transfer Orbit Stage (TOS) combination). Mars Surveyor will use a more distributed risk approach, involve launching multiple spacecraft at each opportunity, minimizing the risk associated with each event. All Mars Surveyor spacecraft to be built by industry; in addition, technology and education investments will be integral components of the program from the beginning. Mars Surveyor will also build a sound basis for future international collaboration on Mars exploration.

Question. In my view, NASA's aeronautics research is critical to maintaining U.S. leadership in aerospace. However, I notice that NASA's aeronautics budget has been cut by almost 20 percent. What impact will this cut have on NASA's aeronautics activities?

Answer. The FY 1995 budget request reflects the new budget structure. As a result of this new structure, the $212 million included in the Construction of Facilities appropriation in FY 1994 is now included in the Aeronautics budget. Additionally, in FY 1994 funding for the Small Business Innovative Research/Small Business Technology Transfer program was included in the individual program area. Beginning in FY 1995, the agency has identified funds for this activity separately, and they are included in the Office of Advanced Concepts and Technology budget request. The FY 1995 portion of this program is $19.7 million. With these changes taken into account, funding for Aeronautics Research and Technology activities between FY 1994 and FY 1995 remains virtually unchanged.

As part of the FY 1995 budget development exercise, NASA conducted a major institutional rightsizing effort to streamline its internal operations. Significant savings were identified in the R&T Base in areas with the least, or no, impact on priority programs, including:

Aircraft Reductions. Streamlined operations and focus on highest-priority efforts will enable the deactivation of 10 research and support aircraft, and reduced usage of an eleventh aircraft.

Facility Closures and Efficiencies. The aeronautics program will close four facilities, place an additional six facilities on stand-by status, and reduce operations in eight other facilities. These facilities include wind tunnels, simulators, and engine test cells. All required and prudent maintenance and environmental investments will be continued.

Operation of Installation Efficiencies. Internal operations at NASA's four aeronautics centers have been "right-sized" through consolidation of automated data processing and other computational efforts; streamlining of scientific and technical information processing and general shop and support services; and reductions in maintenance, printing, reproduction, transportation, and other installation services.

The savings in the Research and Technology Base were used to enable the increases in the focused aeronautics programs (e.g., Advanced Subsonic Technology, High Speed Research, and High Performance Computing and Communications) that will provide additional returns to the country from the standpoint of technology development, job creation, and sustained competitive advantage.

Question. It is my understanding that NASA will require at least $3 billion over the next five years to build new wind tunnels. The tunnels will be needed to enable U.S. industry to stay competitive in the civil transport market. However, the aeronautics budget request includes no money for the new wind tunnels. Why didn't NASA ask for any wind tunnel funding? If NASA does later commit to new wind tunnel construction, where will the billions of dollars come from?

Answer. Slightly more than a year ago, NASA, in conjunction with the Departments of Defense, Commerce, Energy, and Transportation initiated a major review of all existing space and aeronautics facilities, both government and industry. The National Facility Study, which is the end product of this activity, is complete.

A key finding in the aeronautics portion of the Study is the need for two new wind tunnels—one subsonic facility and one transonic facility. Based on the government/industry assessment, these two new facilities would be needed shortly after the turn of the century and would provide the U.S. aerospace industry with a competitive edge for the next round of wide body commercial transport competition. The total cost of these facilities is estimated at $2.6 billion.

In FY 1994, the Administration requested, and Congress appropriated, $74 million for advanced studies related to these facilities. At present, NASA, the Administration, and industry are examining a variety of financing, construction, and management approaches to develop a viable set of options that would enable a possible decision to proceed with the tunnels, potentially for consideration in the FY 1996 budget cycle. (Small amounts of the $74 million in FY 1994 funding are being used to support this examination.) Some of the options being developed feature various combinations of public and private sector contributions.

Question. Does the U.S. have wind tunnels capable of producing subsonic and transonic flight conditions? Does the U.S. have wind tunnels capable of producing hypersonic flight conditions?

Answer. The United States does have numerous wind tunnels that are capable of producing various aspects of subsonic and transonic flight conditions. However, the National Facility Study (mentioned above) has determined that current U.S. tunnels do not have sufficient Reynolds number capability to fully simulate the flight conditions of today's complex subsonic commercial transport aircraft, nor the productivity required by industry in today's competitive market. (Many of the subsonic and transonic wind tunnels in use today are specialized research facilities, as opposed to production tunnels.) In the absence of this capability, U.S. industry has

been using more capable and productive European facilities at a higher cost and at the risk of unwanted technology transfer. (The National Facility Study task group also looked at upgrades of existing tunnels, but determined that required operational parameters could not be met without new tunnels.)

The United States also has wind tunnels capable of producing hypersonic flight conditions. Major aerodynamics/aerothermodynamic facilities include the NASA Langley Research Center (LaRC) Hypersonic Test Complex, the NASA Ames Research Center (ARC) 3.5 Foot Hypersonic Wind Tunnel, the Naval Surface Warfare Center hypersonic tunnels, Air Force Tunnels at Arnold Engineering Development Center (AEDC) and Wright Laboratory, DOE Sandia Laboratory, and various university/industry facilities. Major hypersonic propulsion and high temperature and pressure materials and structures test facilities include five LaRC tunnels, the largest of which is the 8-foot High Temperature Tunnel, a 16-inch Shock Tunnel and direct-connect arc-heated facility at ARC, the NASA Lewis Research Center Plumbrook Hypersonic Test Facility, a shock tunnel and arcjet at AEDC, and several university/industry facilities.

While each facility represents significant capabilities, none can fully replicate true flight conditions at high Mach numbers. Some facilities use helium or nitrogen as the working gas instead of air; some are limited in temperature; some are limited in pressure; many are limited in test article size; and, above about Mach 10, all are very limited in test duration (usually measured in milliseconds). This is especially true for propulsion facilities, and is the principal reason that airbreathing-propulsion flight experiments are required at high Mach numbers.

Question. Why are wind tunnels in the United States needed for the development of advanced aeronautics such as the High Speed Civil Transport or a National Aerospace Plane.

Answer. In general, wind tunnels—in combination with other computational and experimental techniques—are required to reduce the risk and cost of potential aircraft designs before test or production aircraft are actually constructed and flown. For example, in today's highly competitive subsonic commercial transport market, small miscalculations of a proposed aircraft design's drag can translate into major miscalculations regarding fuel economy that could make or break a new market entrant. Highly reliable and productive wind tunnels are required to enable aircraft designers to determine such technical characteristics prior to production commitment decisions.

As mentioned above, if such facilities are not available in the United States, and U.S. industry is forced to use foreign-owned and operated wind tunnels, U.S. industry faces higher cost, more limited availability, and the potential for unwanted technology transfer.

It should be noted that no new wind tunnels are required to conduct the High Speed Research (HSR) Program, the joint NASA/industry research and technology effort that will support industry's decision to embark upon the development of a High Speed Civil Transport.

Question. When is foreign competition expected to produce a new civil transport? Or a space plane?

Answer. Due to the extremely high cost, and risk, involved in developing all new airplanes, aircraft manufacturers rely heavily on derivatives—modifications of existing products featuring extended range, increased passenger capacity, or other items of interest to their airline customers—to maintain an edge in the commercial transport market. Derivatives appear on the average every two or two-and-a-half years. With respect to an all new large commercial aircraft, it is not anticipated that the Europeans will introduce such a product prior to the turn of the century. More revolutionary civil transports, such as the Very Large Commercial Aircraft or the High Speed Civil Transport, are not likely to be introduced until after the middle of the first decade of the twenty-first century. However, given the long lead times required to develop new aircraft, and the risk associated with not being the first manufacturer to market with a new product offering, timely research and technology development efforts are crucial.

Because of the potential, many foreign nations and groups of foreign nations are currently working toward space planes. Japan has a multi-year plan to field an aerospace plane in the first decades of the twenty-first century. Current and planned Japanese investments in hypersonics are about on a par with the United States (in FY 1994 and beyond). In Europe, the European Space Agency has crafted the Future European Space Transportation Investigations Program (FESTIP), which is aimed at integrating and focusing European technology-development activities for space-launch aerospace planes. Most European Community countries, with the exception of France, are participants. Again, the level of investment is about the same as that in the U.S.

Question. Does it make sense not to begin some research needed to develop a hypersonic wind tunnel?

Answer. It does makes sense to continue research on hypersonic wind tunnels, and a limited amount (i.e., facility contamination research) is underway. While there are many hypersonic wind tunnels, none can fully duplicate hypersonic flight conditions. Some facilities use gases other than air; all have a combination of altitude, pressure, or test article size limitations; and—above about Mach 10— all are very limited in test duration (usually measured in milliseconds). Additional wind tunnel research would help remove some of these limitations. However, because of limited funding, additional research will be severely restricted.

Question. I understand NASA plans to fund an unsolicited proposal from a group consisting of MSE, Inc., in Montana; the University of Tennessee, Tullahoma, TN; the University of Texas-Arlington in Texas; and the Russian Aero-Hydrodynamics Institute in Moscow. The purpose is to perform systems studies and pilot scale work. If this is correct, when does NASA expect to announce the decision?

Answer. An unsolicited proposal has recently been received. It will be evaluated and a funding determination made according to standard NASA procedures for handling unsolicited proposals.

Question. What technology spin-offs could be expected from aeronautics projects including wind tunnel and material studies leading up to them?

Answer. It is important to note that "technology spinoffs" should be used somewhat carefully when dealing with the aeronautics program. In contrast to NASA's space missions, where commercially valuable products are typically developed only as by-products of scientific or exploration missions, NASA's aeronautics program is directly geared toward developing technologies that will have valuable commercial or other (i.e., safety, environmental, defense) applications.

For example, NASA recently developed the Cockpit Weather Information Needs (CWIN) system, an integrated weather display and route analysis system that will enable airlines to save almost $6 million per year each through increased fuel savings. NASA research and technology efforts have also supported U.S. aircraft manufacturers in the development and introduction of weight-saving composite secondary structures (e.g., rudders and elevators), full-authority digital electronic controls, autonomous deicing systems, and fly-by-wire systems (scheduled for introduction in 1995 on the Boeing 777). These are but a sampling of NASA's aeronautics technology at work, improving the competitive posture of the domestic aeronautics industry.

There are also, however, instances where NASA-developed aeronautics technology is applied in ways not originally envisioned—the aeronautics version of "spinoffs." For example, technology developed in part by NASP has led the way to the use of metal matrix composite (MMC) compressors in demonstration gas turbine engines, featuring lower weight, higher speeds, and less fuel consumption. (A more detailed treatment of NASP spinoffs is addressed in a later response.) And, advances in one technology area may lead to unexpected advances in other areas. For example, if built, the two new wind tunnels may also stimulate research in virtual reality and other information technologies (e.g., neural nets) as industry and NASA work to incorporate the tunnels into an efficient aircraft design and testing system.

Question. One of the principal recommendations of the 1990 Augustine Committee Report was that NASA should proceed with the National Aerospace Plane (NASP) program. I believe that NASP technology offers the potential for breakthrough applications in civil space, commercial aviation, and national defense. However, in the FY 1995 budget request, NASP has been eliminated and folded into a generic hypersonic research program which focuses on propulsion research. Why was NASP cut from the budget request?

Answer. In FY 1994 Congress directed NASA and the Department of Defense to conclude the NASP technology development phase and pursue a vigorous hypersonics technology program. The FY 1995 budget request will enable NASA, in partnership with the Air Force, to pursue a bold, but frugal, program focused on high Mach number propulsion flight experiments.

Question. How will the hypersonic research program, which receives $40 million in the request, differ from the current NASP program? What are the main goals and priorities of the hypersonic research program?

Answer. The NASP program was focused on the development, construction, and flight test of a hypersonic research aircraft, the X-30. The new Hypersonic Technology program will address key hypersonic challenges, specifically high-Mach-number airbreathing propulsion, that are the most crucial tasks leading to a U.S. aerospace plane. However, the new program does not include a flight research aircraft.

The main goals and priorities include joint research with the Air Force on high Mach number (nominally Mach 15) supersonic combustion ramjet (scramjet) oper-

ability and performance. This activity would include integrated computational, wind-tunnel and flight research (using surplus ICBM boosters), and supporting technology development such as instrumentation. In addition, the NASA Hypersonic Technology program will include a Mach 5 aerodynamic flight experiment as a piggyback on a scheduled Pegasus satellite launch, a planned low-cost Mach 7 subsonic combustion ramjet to scramjet transition flight experiments using Russian hardware and flight facilities, and other activities structured to further hypersonic technologies while maintaining critical capabilities.

Question. Would you provide me with a list of the commercial technology spinoffs resulting from NASA's space and aeronautics programs?

Answer. Spin-offs from the aeronautics program in general were addressed in response to a previous question. Spin-offs from the NASP program specifically are detailed in the two enclosures, National Aero-Space Plane Program Technology Spinoffs and NASP: The Transfer of NASP Technologies. A third enclosure, entitled Spinoff '93, highlights recent spin-off technology contributions from all of NASA's program activities.

Question. I indicated earlier in my opening remarks that NASA estimates the commercial space plane market at $460 billion. Would you also provide me with NASA's estimate of a National Aerospace Plane's economic impact on the U.S. economy?

Answer. As NASP is aimed at very advanced technologies for potential civil and military applications, estimates of its eventual impact on the economy are difficult to make. Several studies of the economic impact of NASP technologies, however, have predicted an increase in the competitiveness of U.S. industries from productivity gains brought about by NASP technologies. While these predictive macroeconomic studies should be considered with the full list of assumptions and caveats, they do serve to highlight the potential for beneficial trends, particularly in key segments of the economy.

By way of comparison, NASA's Aeronautics program also includes the High Speed Research program, which, for example, is providing technology for a potential High Speed Civil Transport (HSCT) that could be built by industry early in the next century. One industry market study indicates that if U.S. manufacturers successfully build and market an HSCT, they could realize $200 billion more in sales than if a foreign competitor successfully introduced an HSCT, and create an average of 140,000 jobs over a fifteen-year period.

QUESTION ASKED BY SENATOR PRESSLER AND ANSWERS THERETO BY MR. GOLDIN

Question. Can you give us a rough outline of NASA's plan for the Landsat program?

Answer. We are pursuing the option presented by NASA to the National Science and Technology Council (NSTC) Deputies Committee and forwarded by this committee to the President's Science Advisor. The option calls for the transfer of the Department of Defense's (DoD) responsibilities for Landsat 7 space systems development to NASA, involving the transfer of the current development contract and the associated FY 1994 funds (including both those funds already obligated on the contract and those yet unobligated). A transition plan between DoD and NASA has already been signed. NASA and the National Oceanic and Atmospheric Administration (NOAA) will share in the development of the ground system, and NOAA will perform spacecraft and ground system operations. The United States Geological Survey will be responsible for archival of Landsat 7 data. The option targets the launch of Landsat 7 into orbit in FY 1999. The Congress has mandated that NASA provide a funding plan certified by the Administrator for the Landsat 7 program (P.L. 103-211) prior to the transfer of any appropriated funds. This plan is still under development and should be completed this spring.

Question. When do you anticipate presenting NASA's Landsat plan to the National Science and Technology Council?

Answer. The NSTC Deputies Committee has already received a presentation, and the Office of Science and Technology Policy (OSTP) is drafting a revision to the President's National Space Policy Directive on Landsat Remote Sensing Strategy to provide direction to the agencies involved. We currently expect resolution of issues sometime in April. The Landsat 7 funding plan required by the Congress will be coordinated with the OSTP prior to submission.

Question. I understand that NOAA may have difficulty coming up with the funding for operation of the ground operations for Landsat 7. Is NASA prepared to assume ground operations in the event NOAA is unable to operate the system?

Answer. Both agencies face challenges in obtaining the necessary funds to pursue the Landsat 7 program. Both agencies also recognize the importance of a successful Landsat 7 program to maintaining the continuity of land remote sensing data for global change research, agriculture and other applications, and have committed to request the necessary funds. NASA is counting on NOAA's participation.

Question. Has NASA an estimate on the cost of the ground operations for Landsat 7? If so, what is this estimate based upon?

Answer. NASA is incorporating ground operations costs for Landsat 7 into the funding plan required by the Congress. It is based on input from NOAA and reflects their experience in preparing for Landsat 6 operations, and on the spacecraft requirements and ground systems architecture provided by NASA.

Question. As you know, the Earth Remote Observing Satellite Data Center (EDC), has a key role in the EOSDIS program. Landsat is a bridge to EOSDIS. Is NASA looking at Landsat 7 ground operations in the context of the EOSDIS program? If not, I would like to request that NASA look at Landsat 7 ground operations in this context. Can you give me this assurance?

Answer. The plan NASA is developing for Landsat 7 incorporates the EOSDIS Distributed Active Archive Center at EDC into the ground system architecture as the data archive and distribution center. Data formats and standards will comply with those established for EOSDIS. This will ensure that Landsat 7 data is available and readily usable by the global change research community.

Question. With respect to Landsat 7 ground operations, has NASA consulted with the Department of the Interior, which has 25 years' experience with ground operations, data processing, distribution and archiving at EDC?

Answer. NASA is continuing to work closely with the United States Geological Survey of the Department of the Interior to ensure the active participation of the EDC in the ground system architecture for Landsat 7 to accomplish these functions. Once the program is approved, NASA, USGS, and NOAA will develop and sign a joint management plan defining the roles of each agency.

Question. Has NASA considered potential policy with respect to the EOSAT contract, which I understand expires this summer?

Answer. On behalf of Landsat Program Management, NASA has been negotiating an agreement with EOSAT on the continued operation of Landsats 4 and 5. Under the terms of this agreement, which is intended for incorporation by the Department of Commerce into its contract with EOSAT, EOSAT would operate Landsats 4 and 5 until their practical demise, and would have exclusive marketing rights to data acquired between July 1994 and that time until six months after the practical demise of these spacecraft. EOSAT would provide data to the US Government and its affiliated users at preferential prices and with certain rights to reproduce and distribute data within that user group. The proposed agreement is consistent with the Land Remote Sensing Policy Act ot 1992 (P.L. 102-555, Article 103).

QUESTION ASKED BY SENATOR HUTCHISON AND ANSWER THERETO BY MR. GOLDIN

CENTERS FOR THE COMMERCIAL DEVELOPMENT OF SPACE

Question. Texas is home to two of the 17 NASA Centers for the Commercial Development of Space (CCDSs). One is at Texas A&M (which does space power systems research) and the other is at the University of Houston (the Space Vacuum Epitaxy Center—which does materials purification in space research). Following an extensive peer review, 6 existing centers will be phased out and another peer review will be conducted next year. The Texas CCDSs were not among those phased out but will be reviewed again next year. What is your assessment of the work done at the Texas CCDS?

Answer. Overall, the Texas CCDS's have both been performing above average, but the 1993 Peer Review found both to have weaknesses in "commercial planning and commitment." This industry focus should be the underpinning structure for each CCDS. Since both CCDS's were established in 1987, they are expected to have long term industry partnerships in place and show maturity in the industry vision, leadership, and commitment. Each of the Texas CCDS's fell short of high marks for different reasons.

Some specific observations:

1. University of Houston-Space Vacuum Epitaxy Center (SVEC). This CCDS has chosen a long-term focus that could demonstrate economic success in the microelectronics industry. Through innovation in the CCDS's ground-based thin-film research and technology development to support molecular beam epitaxy materials in the ultra vacuum of space, it is pioneering leadership in science, research, development,

and commercial applications. SVEC has, also, demonstrated successful technology transfer in superconducting materials and improved (highly efficient) solar cells.

The Center's industry cash funding, leveraged by the base grant, was 7 cents on the dollar. The industry in-kind was about 30 cents on the dollar, which was still short of what we expect for a CCDS established over 6 years ago.

SVEC has done fairly well in leveraging other funds to support its activities; these other funds are, however, not indicators of an industry-driven program. To continue as a CCDS, SVEC will have to demonstrate a greater degree of responsiveness and commitment by the U.S. industry.

2. Texas A&M University-Center for Space Power (CSP). CSP has carried out a unique program of interest to both large and small companies. On the surface, CSP has appeared to be a contract research operation; however, it has changed its scope and is showing clear signs of developing a solid commercial program. A recent (mid-term) review of CSP showed increasingly strong evidence of long-term industry commitment to the CCDS. The CCDS has moved away from some of its projects that were draining the CCDS's attention and resources, such as power-beaming. The focus on solid industry planning and commitments, if formalized and sustained, could make this a strong CCDS in the near future.

CSP enjoys a high ratio of cash contributions to the NASA base funding; i.e., $1.60 to each NASA dollar in 1993, including industry cash of.71 cents and funding from universities, other Federal Agencies, and States.

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